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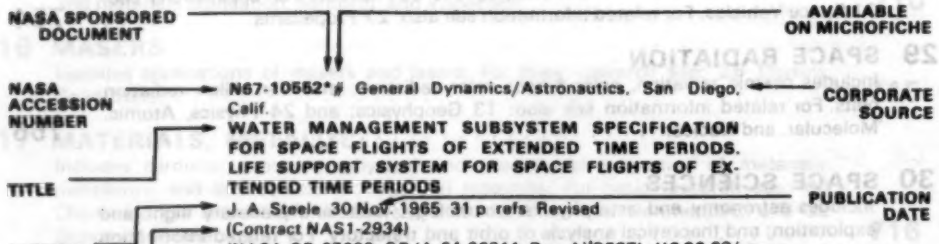
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N67-10552*# General Dynamics/Astronautics, San Diego, Calif.
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TITLE
WATER MANAGEMENT SUBSYSTEM SPECIFICATION FOR SPACE FLIGHTS OF EXTENDED TIME PERIODS. LIFE SUPPORT SYSTEM FOR SPACE FLIGHTS OF EXTENDED TIME PERIODS
PUBLICATION DATE
J. A. Steele 30 Nov. 1965 31 p refs Revised
AUTHOR
(Contract NAS1-2934)
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(NASA-CR-67600; GD/A-64-26211, Rev. A) CFSTI: HC $2.00/MF $0.50 CSCL 06K
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REPORT NUMBER
The water management subsystem specifications are presented for the equipment required in an operational water management program as an integral part of the life support system for space flight. The requirements of the subsystem components are summarized and the operational procedures for normal and emergency situations are outlined. Both the prototype and the flight systems are discussed. E.E.B.
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VOLUME 5 NUMBER 5

# Scientific and Technical Aerospace Reports

*A Semimonthly Publication*
*of the National Aeronautics and Space Administration*

*March 8, 1967*

## 01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbo machinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.

N67-14609# Aeronautical Research Council (Gt. Brit.)
**GENERALISED AERODYNAMIC FORCES ON A T-TAIL OSCILLATING HARMONICALLY IN SUBSONIC FLOW**
D. E. Davies London, HMSO, 1966 74 p refs Supersedes RAE-TN-STRUCT-295, ARC-26303
(ARC-R&M-3422; RAE-TN-STRUCT-295; ARC-26303) CFSTI: HC $3.00/MF $0.75

The T-tail under investigation consists of a flat horizontal tailplane mounted on top of a flat vertical fin. The chords of the two surfaces at their junction are of the same length and are coincident. The T-tail is assumed to be isolated and to be oscillating harmonically in a subsonic flow whose main stream is parallel to the mean positions of the surfaces of the T-tail. The linearised equations of potential flow are assumed to be valid. A pair of integral equations relating the normal air velocities on the surfaces of the tailplane and fin with the loading distributions on these surfaces is derived. This pair of simultaneous equations is solved approximately by collocation and the loading functions so determined are used to calculate generalised airforces on the T-tail at any frequency of oscillation. When the T-tail is attached to an aircraft there is some aerodynamic interaction between the aircraft fuselage and the T-tail. It has not been possible to estimate this interaction in general. If the T-tail is attached to an infinite wall with the tailplane parallel to the wall then it is possible to obtain the interaction by the method of images with the infinite wall acting as a reflector. This approaches conditions in a wind tunnel, so a treatment of this case has been given. This case may also be a guide to the more general case of interaction between a fuselage and a T-tail. Author

N67-14610# Aeronautical Research Council (Gt. Brit.)
**THE LATERAL OSCILLATION OF SLENDER AIRCRAFT**
A. J. Ross London, HMSO, 1966 38 p refs Supersedes RAE-TN-AERO-2666, ARC-24630
(ARC-CP-845; RAE-TN-AERO-2666; ARC-24630) CFSTI: HC $2.00/MF $0.50

Theoretical estimates of the angle of incidence at which the damping of the Dutch-roll oscillation of various slender-wing configurations becomes zero are derived and shown to agree well with the critical angle of incidence, observed experimentally, at which free-flying models undergo a sustained oscillation. Some approximations to the frequency and damping of the oscillation are compared with the exact values, with satisfactory agreement. A criterion for critical angle of incidence is obtained, the complexity of which depends mainly on the inertia distribution of the aircraft. Author

N67-14611# Aeronautical Research Council (Gt. Brit.)
**ACCURACY OF DOWNWASH EVALUATION BY MULTHOPP'S LIFTING-SURFACE THEORY**
H. C. Garner London, HMSO, 1966 16 p refs Supersedes NPL-AERO-1110, ARC-26072
(ARC-R&M-3431; NPL-AERO-1110; ARC-26072) CFSTI: HC $1.00/MF $0.50

The rate of convergence of the spanwise integration to obtain downwash angles at centres of rectangular wings is examined. To ensure accuracy of ±1%, the number of integration points across the wing span should exceed four times the aspect ratio. Systematic numerical studies are needed to establish the accuracy of Multhopp's theory, as commonly applied to wings of moderately high aspect ratio. Author

N67-14892*# Rice Univ., Houston, Tex.
**TWO-DIMENSIONAL, LIFTING WINGS OF MINIMUM DRAG IN HYPERSONIC FLOW**
David O. Hull 1966 31 p refs
(Grant NGR-44-006-045)
(NASA-CR-80964; AAR-24) CFSTI: HC $3.00/MF $0.65 CSCL 01A

The problem of minimizing the drag of a slender flat-top two-dimensional lifting wing in hypersonic flow is considered under the assumptions that the pressure coefficient is Newtonian and the skin-friction coefficient is constant. The indirect methods of the calculus of variations are employed, and the necessary conditions to be satisfied by an optimum airfoil are derived for conditions imposed on the lift, the pitching moment, the profile area, the chord length, and the thickness. Then, the following particular cases are analyzed: given lift; given lift and chord length; given lift and thickness; given lift and profile area; and given lift, pitching moment, and chord length. In all cases, analytical expressions are presented for the geometry of the optimum airfoil and the aerodynamic drag. S.P.

N67-14894*# Rice Univ., Houston, Tex.
**TWO-DIMENSIONAL WINGS OF MAXIMUM LIFT-TO-DRAG RATIO IN HYPERSONIC FLOW**
David G. Hull 1966 37 p refs
(Grant NGR-44-006-045)
(NASA-CR-80959; AAR-25) CFSTI: HC $3.00/MF $0.75 CSCL 01A

The problem of maximizing the lift-to-drag ratio of a slender two-dimensional flat-top wing in hypersonic flow is considered under the assumptions that the pressure coefficient is modified Newtonian and the skin-friction coefficient is constant. Arbitrary conditions are imposed on the chord, the thickness, and the profile area; and the necessary conditions to be satisfied by an optimum wing are derived with the indirect methods of the calculus of variations. Then, several particular cases are analyzed and, for each case, analytical expressions are determined for the optimum shape and the maximum lift-to-drag ratio. Author

**N67-14926*#** Itek Corp., Palo Alto, Calif.
**AN EXPLORATORY STUDY OF THE VORTEX SHEETS SHED FROM THE LEADING EDGES OF SLENDER WINGS**
A. H. Sacks and E. G. Tickner 30 Nov. 1966 18 p refs
(Contract NAS2-2620; Vidya Proj. 9266)
(NASA-CR-73048; VIDYA-234) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Analytical studies were undertaken to extend slender body theory for predicting the forces and moments associated with flow separation from the wing leading edges. The unsteady Bernoulli equation is used as the pressure relation in investigating the shedding of vorticity from a two-dimensional plate whose width is a function of time. A least-squares spiral curve fit was applied to the calculated positions of the shed vortices at each chordwise station, with the result that the predicted vortex sheet shape closely resembles the smooth spiral curves observed experimentally. However, the effect on the calculated normal force and center of pressure on slender wings appears to be insignificant; similarly, the rate of convergence with number of vortices is unaffected. It is concluded that overprediction of the shedding rate and the normal force for wings of finite aspect ratio is brought about by three-dimensional effects which cannot be handled by the slender body theory. A three-dimensional theory is recommended for more accurate predictions. M.G.J.

**N67-14989#** David Taylor Model Basin, Washington, D. C. Aerodynamics Lab.
**WIND TUNNEL INVESTIGATION OF AN ASPECT RATIO 10 TANDEM WING AIRCRAFT CONFIGURATION IN GROUND EFFECT. PART I: LONGITUDINAL CHARACTERISTICS**
Charles W. Harry and Lynn A. Trobaugh Jul. 1966 71 p refs
(DTMB-2259-1; DTMB-AERO-1111-1; AD-641246) CFSTI: HC $3.00/MF $0.75

Subsonic wind-tunnel test results of a tandem wing aircraft configuration are given. Conventional longitudinal tests out of ground effect, and similar tests in ground effect, employing the ground board test technique, were conducted on the configuration. Test variables included height above the surface, forward and aft wing incidence angles, angle of attack, and center-of-gravity location. Author (TAB)

**N67-15008#** Aeronautical Research Council (Gt. Brit.)
**SOME EFFECTS OF THICKNESS ON THE LONGITUDINAL CHARACTERISTICS OF SHARP-EDGED DELTA WINGS AT LOW SPEEDS**
L. C. Squire (Cambridge Univ.) 12 Apr. 1966 24 p refs
(ARC-27913; AD-642181) CFSTI: HC $3.00/MF $0.65

A series of test were made at low speeds in an attempt to find thickness distributions of up to 20% thickness/cord ratio which do not have an adverse effect on the non-linear lift. All the distributions tested do have some adverse effect but it was found that this can be minimized by ensuring that the wing upper surface is flat in the immediate vicinity of the leading edges. Author (TAB)

**N67-15111#** Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
**THE IMPULSIVELY STARTED ELLIPTIC CYLINDER-ORIGIN OF LIFT**
Chang-Yi Wang Jul. 1966 108 p refs
(Contract AF 49(638)-1622); Grant AF-AFOSR-156-65)
(AFOSR-66-1543; Rept.-66-4; AD-641254) CFSTI: HC $4.00/MF $0.75

A theoretical investigation was made of the subsequent transient motion of the flow field due to an impulsively started elliptic cylinder in an infinite fluid. The fluid is assumed to be slightly viscous such that the Reynolds number is large. The Navier-Stokes equations then pose a singular perturbation problem. The behavior at small times is investigated through the method of matched asymptotic expansions. The non-linear transport of momentum from the boundary layer and the induced flow is responsible for the pressure lift. Preliminary results show that the lift behaves as t to the 3/2 power. The phenomenon of stall is also discussed. The flow field induced by an impulsively started circular cylinder is investigated in detail. The induced exterior flow by the boundary layer behaves like a doublet whose strength increases as t to the 1/2 power. The apparent radius of the cylinder increases as more fluid is retarded. The asymmetric part is like a quadrupole increasing as t to the 3/2, which gives a pair of growing eddies behind the cylinder. The results are confirmed by qualitative experiments and existing photographs of the starting process. Author (TAB)

**N67-15183#** Bolkow Entwicklungen K. G., Munich (West Germany).
**IMPROVEMENTS IN EFFICIENCY OF ROTORS DESIGNED TO PROVIDE BOTH LIFT AND THRUST**
K. Pfleiderer *In* AGARD Helicopter Develop. 1966 p 29-56
(See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

This paper is a survey of German contributions to the problem of advanced helicopter systems. It consists of three topics dealing with improvements in efficiency of rotors designed to provide both lift and thrust, and in addition gives some information about compound and stoppable rotor systems. Data are presented on: a rotor with optimum geometry, a rotor with forced lead-lag motion, a tiltable rotor which employs radial lift effects, compounding a rotor with fixed wings, and stoppable, foldable, and retractable rotor systems. Author

**N67-15218*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**INTERACTION EFFECTS OF A CONTROL JET EXHAUSTING RADIALLY FROM THE NOSE OF AN OGIVE-CYLINDER BODY AT TRANSONIC SPEEDS**
Edwin E. Lee, Jr. and Conrad M. Willis Washington, NASA, Jan. 1967 32 p refs
(NASA-TN-D-3752) CFSTI: HC $3.00/MF $0.65 CSCL 01A

An investigation has been conducted to determine the influence of the main airstream upon the control effectiveness of a nose-mounted control jet exhausting radially from an ogive-cylinder body. The control jet was operated at jet total pressures of up to 560 psia ($3861 \times 10^8$ newtons/meter$^2$). Tunnel Mach number ranged from 0.60 to 1.05 with angles of attack ranging from $-4°$ to $8°$. Average Reynolds number was $3.8 \times 10^6$ per foot ($12.5 \times 10^6$ per meter). The pitching moments produced by the control jet were reduced by interactions with the main airstream at all test conditions. The amount of control-moment reduction varied from about 30 to 55 percent of the moment produced by the jet exhausting into quiescent air. Author

**N67-15252*#** Notre Dame Univ., Ind. Dept. of Aero-Space Engineering.
**ON ROLL LOCK-IN IN UNGUIDED ROCKETS**

John D. Nicolaides and Stephen C. Stumpfl 1966 39 p refs Presented at the Conf. on Unguided Rocket Ballistics, Texas Univ., El Paso, Aug. 1966 Submitted for Publication
(Contract NSR-15-004-016)
(NASA-CR-81142; UNDAS-TN-668JDN) CFSTI: HC $3.00/MF $0.65 CSCL 16D

The free rolling motion of three sounding rocket type configurations is studied in a wind tunnel at supersonic speeds. It is found that the models fail to roll when the angle of attack exceeds some critical value. The roll oscillations of the models about the roll trim angle are studied both theoretically and experimentally. The roll lock-in theory is fitted to this experimental data and found to accurately represent the oscillations in supersonic roll lock-in. Also, accurate values for the roll trim angle, the induced roll moment stability coefficient, and the roll damping moment stability coefficient are obtained. Abnormalities in the observed free rolling motions are also discussed. Roll lock-in is found to be due to the fins alone and new configurational studies are suggested.
Author

N67-15290# United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.
**A PRESENTATION OF MEASURED AND CALCULATED FULL-SCALE ROTOR BLADE AERODYNAMIC AND STRUCTURAL LOADS** Final Report
J. P. Rabbott, Jr., A. A. Lizak, and V. M. Paglino Jul. 1966 182 p refs
(Contract DA-44-177-AMC-53(T))
(SER-58398; USAAVLABS-TR-66-31; AD-639981) CFSTI: HC $5.00/MF $1.00

A test of a set of Sikorsky CH-34 rotor blades was conducted in the NASA/Ames full-scale wind tunnel at speeds of 110 to 175 knots. One blade of the set was instrumented to measure differential chordwise pressures, as well as flapwise, chordwise and torsional stress. The test results are presented, two- and three-dimensional pressure distributions are compared, and a correlation of airloads and blade stresses is made with a flexible blade aeroelastic theory, including both uniform and variable inflow assumptions. Correlation of airloads and stresses with theoretical results was generally good. Inclusion of variable inflow improved correlation on both advancing and retreating sides of the disk at speeds as high as 175 knots, but the need for a more precise wake treatment is indicated. There is also evidence of a requirement for including lifting surface effects in the calculation at the advancing blade tip. A comparison of some of the wind tunnel data with flight test results shows good agreement. Author (TAB)

# 02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N67-14748# Naval Air Development Center, Johnsville, Pa.
**INVESTIGATION OF THE MANUAL OVERRIDE TRIM SWITCH USED IN THE AD TYPE AIRCRAFT** Final Report
J. P. Triolo 29 Aug. 1966 10 p refs
(NADC-AE-6629; AD-640135) CFSTI: HC $1.00/MF $0.50

The NAVAIRDEVCEN laboratory investigation indicated that the run-away trim condition reported in the AD type aircraft could be attributed to malfunctioning of the manual override trim switch. Failure of the switch was caused by a deficiency of the material used for the internal construction of the control solenoids.
Author (TAB)

N67-14935*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
**STATISTICAL ANALYSIS OF LANDING CONTACT CONDITIONS OF THE X-15 AIRPLANE**
Ronald J. Wilson Washington, NASA, Jan. 1967 20 p refs
(NASA-TN-D-3801) CFSTI: HC $1.00/MF CSCL 01C

The landing contact conditions and slideout distances for 135 landings of the X-15 research airplane are discussed. The conditions are similar to those that might be experienced by future lifting-body reentry vehicles or other flight vehicles with low lift-drag ratios. Results are presented in the form of histograms for frequency distributions, and Pearson Type III probability curves for the landing contact conditions of vertical velocity, calibrated airspeed, true ground speed, rolling velocity, roll angle, distance from intended touchdown point, and slideout distance. Additional statistical parameters presented for each of the described conditions are the mean, standard deviation, and the coefficient of skewness.
Author

N67-14936*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**LARGE-SCALE WIND TUNNEL TESTS OF A SUBSONIC TRANSPORT WITH AFT ENGINE NACELLES AND HIGH TAIL**
Kiyoshi Aoyagi and William H. Tolhurst, Jr. Washington, NASA, Jan. 1967 47 p refs
(NASA-TN-D-3797) CFSTI: HC $2.00/MF $0.65 CSCL 01C

The static longitudinal stability and control effectiveness at angles of attack above those for wing stall was investigated for a large-scale subsonic transport model with a 35° swept wing of aspect ratio 6.38. The model was tested with the nacelles in several locations and with wing leading- and trailing-edge high lift devices. Pitching moment and longitudinal control characteristics of the model and three-component longitudinal data are presented. Downwash angles and dynamic pressures in the horizontal tail plane location and nacelle inlet pressures are also presented. The static longitudinal stability and control effectiveness of the model was reduced substantially at angles of attack above that for wing stall. The nacelles did not decrease the longitudinal stability and control effectiveness of the model for angles of attack up to 30°. Small changes in the nacelle locations or deflections of the trailing-edge flaps did not significantly improve the longitudinal stability or control effectiveness. However, the use of leading-edge slats did improve both these characteristics at angles of attack above the wing stalling angle. Sideslipping the model seemed to improve the pitching-moment characteristics.
Author

N67-14938*# Ling-Temco-Vought, Inc., Dallas, Tex.
**STUDY ON THE FEASIBILITY OF V/STOL CONCEPTS FOR SHORT-HAUL TRANSPORT AIRCRAFT**
K. R. Marsh Washington, NASA, Jan. 1967 208 p refs
(Contract NAS2-3036)
(NASA-CR-670) CFSTI: HC $3.00/MF $2.60 CSCL 01C

A feasibility study has been performed in which eighteen airplanes have been developed around three V/STOL propulsion concepts, four V/STOL operational capabilities, and three passenger-load capabilities. Each of the airplanes developed has been optimized to give a near minimum direct operating cost on the design stage length of 500 miles within the constraints of its selected V/STOL propulsion system, V/STOL operational capability and passenger-load capability. This study has found the turboprop

V/STOL airplanes to have only modest cruise speed capabilities, relatively low direct operating costs, and comparatively light weights; and there are considerable data to guide the designer of turboprop V/STOL aircraft. The fan-in-wing V/STOL airplanes have a relatively high cruise speed, high direct operating costs, and high propulsion system plus fuel weights and hence gross weights. There are considerable data available to the designer of fan-in-wing airplanes though not as voluminous or complete as for the turboprop. The propulsive wing V/STOL airplanes have high subsonic cruise speed capabilities, low direct operating costs, and relatively light weights; but there are only limited data to guide the designer of such aircraft. Author

**N67-14943#** Lockheed-California Co., Burbank.
**WINGED HULL STABILITY AND CONTROL STUDY**
W. A. Swope, J. F. Herman, M. L. Jager, and P. F. Bala 1 Aug. 1966 149 p refs Revised
(Contract NOw-63-0588-d)
(LR-17910; AD-641901) CFSTI: HC $5.00/MF $1.00

The report presents an analysis of the stability, control, and response characteristics of a large airborne vehicle when flying close to a water surface. The effects of both smooth water and waves were considered. An analysis of water contact for a variety of conditions is also included. TAB

**N67-15015#** Bell Aerosystems Co., Buffalo, N. Y.
**A GENERALIZED EXPERIMENTAL STUDY OF INLET TEMPERATURE RISE OF JET V/STOL AIRCRAFT IN GROUND EFFECT**
Robert F. Speth and P. E. Ryan [1966] 159 p refs
(Contract N600(19)63320)
(Rept.-2099-928003; AD-641610) CFSTI: HC $5.00/MF $1.00

Reduction in exhaust pressure ratio (weight flow) had very little effect on the inlet temperature rise. Reduction in exhaust gas temperature lowered the inlet air temperature significantly. Large changes in wing area and variations in lift engine inlet/exhaust arrangements caused no consistent or significant trends in inlet temperature rise characteristics. In dual lift engine configurations the forward inlet experiences somewhat higher temperatures than the aft inlet. Changes in wing planform shape and height on the fuselage had no appreciable influence on lift engine inlet temperature rise. Forward facing side inlets experience large rises in air temperature for any exhaust nozzle arrangement. Typical aircraft components such as flaps, slats, inlet/exhaust doors, and landing gear have very little influence on inlet temperature rise. Deflecting the exhaust gases rearward, as in the case of STOL operation, reduced inlet temperature rise significantly at relatively low forward speeds. Moderate headwinds cause a rapid increase in inlet air temperature up to 15 to 20 fps after which the temperatures reduce somewhat. The magnitude of temperature rise is dependent on the inlet/exhaust arrangement. The motion during vertical ascent and descent apparently alters the pattern of hot gas recirculation and reduces the net inlet temperature rise considerably. TAB

**N67-15181#** Advisory Group for Aerospace Research and Development, Paris (France).
**HELICOPTER DEVELOPMENTS**
1966 582 p refs In FRENCH and ENGLISH Proc. of a Technical Meeting, held in Paris, 10–14 Jan. 1966; Sponsored by AGARD (AGARD-CP-7) CFSTI: HC $8.81/MF $2.50

Conference papers on high speed capability improvement, range-payload, gross weight-lifting ability increase, handling qualities and navigation aids, maintenance and reliability, and vibration are presented. For individual titles see N67-15182–N67-15210.

**N67-15182#** Sud-Aviation, Marignane (France).
**LIMITATION ON THE VELOCITY OF FREE HELICOPTERS BY THE PROBLEMS OF CONSTRAINT [LIMITATION DE LA VITESSE DES HELICOPTERES PURS PAR LES PROBLEMES DE CONTRAINTES]**
Ferdinand Liard *In* AGARD Helicopter Develop. 1966 p 1–28 In FRENCH (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

Briefly treated is the problem of resisting the increased vibration that accompanies an increase in translation speed. Reduction of blade loading is mentioned, and technical details are portrayed in numerous graphs and charts. Increased speed would require helicopter designs that overcome the problems of aerodynamic load, aircraft element response, and component resistance as a function of minimal weight. Transl. by R.Ll.

**N67-15184#** Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
**SOME CONTRIBUTIONS TO THE PROBLEMS OF HIGH SPEED ROTORCRAFT**
G. Kannamueller *In* AGARD Helicopter Develop. 1966 p 57–75 (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

A high speed rotor concept was developed and subjected to intensive wind tunnel tests in an effort to determine the operating limits of a rotorcraft cruising at high speed. The first objective of the test was to find the limits of control power of the very stiff, unloaded rotor up to advance ratios of 1.2. A special study examined the feasibility of a lifting hub, achieved by fairing the rotor hub into a lens-shaped circular wing. Results showed that the lift/drag ratio of the adjustable wing was superior. The circular wing adapted least to the different operating states. Comparative data on different devices for additional thrust, and the concept of a propulsion yaw control and rotor torque compensation are presented. Two compound helicopter projects, a consequence of these results, are illustrated. S.C.W.

**N67-15185#** Bell Helicopter Co., Fort Worth, Tex.
**THE PROMISE OF COMPOUNDING**
Jan M. Frees and Robert R. Lynn *In* AGARD Helicopter Develop. 1966 p 77–111 refs (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

The current state-of-the-art of rotorcraft technology is summarized, possible improvements are noted, and the potential of future rotorcraft technology is assessed. The approach taken is designed to establish probable characteristics of future rotorcraft and to judge their relative potential with the pure helicopter as the basis for comparison. For this study, turbine-powered, gear-driven, single-rotor machines are used. It is believed that this power plant type and transmission will remain the primary energy converter system through the 1970's. This study is limited to the consideration of rotorcraft with gross weights ranging from 2500 to 30,000 lb. Included are data on component weight and disposable load, hovering performance, forward flight performance, lift-drag efficiency, structural loads and vibrations, dynamic and aeroelastic design concepts, stability and control of compound helicopters, noise, and loaded rotors at high advance ratios. S.C.W.

**N67-15186#** Army Aviation Material Labs., Fort Eustis, Va.
**THE PROMISE OF COMPOUNDING**
Andrew B. Connor *In* AGARD Helicopter Develop. 1966 p 113–126 refs (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

Experience with research compound helicopters indicates that compounding promises high performance, agility, and basically good handling qualities. Speeds in the 300-knot range, lift/drag ratios in the range of 7.5, and quiet rotor operation are all within

the realm of reality and can be attained with the present state of the art. It appears that the only difficulty in achieving this almost ideal V/STOL airplane is the execution of the concept. Some special problems have been noted with the compounds during the Exploratory Development Program, but their solutions are more intriguing than difficult. Author

**N67-15187#** Westland Aircraft, Ltd., Yeovil (England).
**PREPARED COMMENTS ON THE PAPERS BY J. M. DREES AND A. B. CONNOR**
G. S. Hislop *In* AGARD Helicopter Develop. 1966 p 127–131 (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

A critical analysis is presented on two papers describing helicopter design concepts. Aspects covered include: economical operation, lift, drag, and wing weight load, cruising speed, blade stresses, stability and control, yaw, and power loss. It is suggested that more effort should be made on the winged helicopter which offers attractive performance in economics, without the speed advantage of the compound, but also without the added complexities. R.L.I.

**N67-15188#** Westland Aircraft, Ltd., Yeovil (England).
**THE COMPOUND HELICOPTER**
D. M. Davies and G. S. Hislop *In* AGARD Helicopter Develop. 1966 p 133–140 (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

Design concepts are reviewed for the optimization of compound helicopters (i.e., rotor plus wing propulsion). Emphasized is the application to aircraft that can take off vertically and cruise with helicopters but then accelerate considerably to avoid enemy fire. Mentioned are cruising speed, partial compounding by addition of thrust, sharing of lift between wing and rotor, low speed directional control, as well as structural compensation for low-altitude, high-incidence, gusts. Application of the proposed design is mentioned for civil transport. R.L.I.

**N67-15189#** United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.
**RANGE-ENDURANCE-PAYLOAD FACTORS AND THEIR RELATIVE IMPORTANCE DEPENDING ON MISSION**
E. S. Carter, Jr. and J. R. Olson *In* AGARD Helicopter Develop. 1966 p 141–175 refs (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

VTOL aircraft design concepts are reviewed for range, endurance, payload, and hovering mission requirements. The parameters for comparative analysis mentioned are: payload versus endurance, productivity versus range, and disposable load versus maximum speed characteristics. Required capabilities are briefly outlined for transport and utility missions, anti-submarine warfare and mine counter measure missions, and escort and reconnaisance missions. R.L.I.

**N67-15190#** United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.
**A NOTE ON HELICOPTER CONFIGURATIONS FOR INCREASED RANGE, SPEED AND ENDURANCE**
Edward F. Katzenberger *In* AGARD Helicopter Develop. 1966 p 177–189 ref (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

The options available to the designer in rotary wing configurations for improving speed, range, and endurance are discussed. The three general configurations for high performance rotorcraft are: the compound helicopter characterized by the fact that the rotor continues to operate in the helicopter mode at high speed; the tilt-rotor helicopter in which the rotor is tilted to the propeller mode for cruise and high speed; and the stowed rotor helicopter, in which the rotor is retracted for cruise and high speed flight. The total system lift/drag ratios of each of these configurations are compared. It is demonstrated that both lift/drag and maximum speed capability increase in progressing from the helicopter, to the compound, to the tilt rotor, and finally to the stowed rotor, which completes the rotary wing evolutions. S.P.

**N67-15191#** Bell Helicopter Co., Fort Worth, Tex.
**AN ANALYSIS OF LOW-DISC-LOADING VTOL AIRCRAFT TYPES**
Robert L. Lichten *In* AGARD Helicopter Develop. 1966 p 191–209 (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

A comparative design study was made of the most promising low-disc-loading VTOL concepts which combine the vertical takeoff and landing capability of the helicopter with the high speed and efficient cruise of the airplane. The VTOL concepts examined were: slow-rotor compound, stopped-rotor, stowed-rotor, tilt-proprotor, tilt-wing, and trail-rotor. These aircraft were designed for high-speed low-altitude transport missions requiring a payload of at least 3000 lb. Each configuration has the same installed power, a lifting rotor disc loading of 10 lb/ft$^2$ and hovers out-of-ground-effect at 6000 ft on a 95°F day at design gross weight. Transport effectiveness comparisons of the six configurations show that the tilt-proprotor, tilt-wing, and trail-rotor have useful loads, productivities and payload delivery efficiencies considerably greater than the other types. The tilt-proprotor configuration is the best of the six configurations examined. In comparison to an equivalent transport helicopter with equal installed power, the tile-proprotor VTOL type at sea level cruises at about double the speed and provides more than double the mission effectiveness. In comparison to an equivalent high-disc-loading tilt-wing design with double the installed power, the tilt-proprotor type cruises at a slightly lower speed but provides double the mission effectiveness. Author

**N67-15192#** Lockheed-California Co., Burbank.
**STOPPED/FOLDED ROTOR VEHICLES**
R. M. Carlson *In* AGARD Helicopter Develop. 1966 p 211–223 refs (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

The stopped/folded rotor concept is evaluated as a direct means of removing the forward flight limitations of the slow rotor compound vehicle. The technical feasibility of stopping and starting a rotor in forward flight is examined. Model tests indicate that vibration level, airframe moments, and rotor blade stresses are minimized if the rotor incorporates no built-in twist and is essentially unloaded during the stop-start cycle. Results of investigations show that the basic loads acting on the blade during the stopping and starting phases can be maintained at or below the normal level of the cyclic loads associated with conventional helicopter operation. This is accomplished by using an aerodynamically stabilized feathering control system that reacts to variations in forward flight speed and pitch attitude of the vehicle so as to feather the blade as it responds to these same variations. Additional data on such factors as weight, costs, and performance predictions are presented for the vehicle designated as the CL-942. S.P.

**N67-15193#** Boeing Co., Morton, Pa. Vertol Div.
**REMARKS ON HIGH SPEED AND PAYLOAD CAPABILITY OF ROTARY-WING AIRCRAFT**
W. Z. Stepniewski *In* AGARD Helicopter Develop. 1966 p 225–252 refs (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

Characteristics of rotary wing aircraft are discussed with respect to lift/drag ratios, maximum speed, and payload. Consideration is given to increased solidity, advanced geometry blades, segmented blades, and auxiliary forward thrust as means of improving speed. Aerodynamic considerations point out that the weakness of the

pure helicopter, and of the compound with auxiliary propulsive thrust, is the poor equivalent lift (weight)/drag ratio of the lifting system throughout the whole speed range. S.P.

N67-15194# Giravions Dorand Co., Paris (France).
**JET FLAP HIGH PAYLOAD HELICOPTER [HELICOPTERE GROS PORTEUR A VOLETS SOUFFLES]**
Rene Dorand *In* AGARD Helicopter Develop. 1966 p 253–280 refs In FRENCH (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

Improvements in performance and development costs of large, high speed, helicopters are discussed. The aerodynamic and propulsion advantages of the increased speed from the jet flap design are summarized, and a comparison of this design with a mechanical helicopter is presented in tabular form. Longitudinal and lateral control features are mentioned, and numerous technical details are given on all phases of the jet flap operation and design improvements. Transl. by R.Ll.

N67-15195# Sud-Aviation, Marignane (France).
**THE TURBOGYRE 330 [LE TURBOGYRE 330]**
Rene Mouille *In* AGARD Helicopter Develop. 1966 p 281–298 In FRENCH; ENGLISH summary (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

The Turbogyre 330 aircraft, which is a combined helicopter-autogyro, has been designed to meet the specifications issued by different nations for a tactical utility VTOL aircraft. Its major design feature is the use of gas generated by two podded jet engines mounted on either side of the fuselage with a view to ensuring actuation of a turbine, coaxial with the rotor and driving this rotor by means of an epicyclic gear; or propulsion, by reaction combined with a turbofan type thrust booster. Its high power ratio renders take-off at maximum permissible weight, from high altitude (1500 m to 4900 ft) and in high temperature conditions (35°C–95°F); high maximum speed of 425 km/h (230 knots). The range, with 1800 kg (4000 lb) payload and 1200 kg (2650 lb) fuel, is 610 km (330 nautical miles). The concept of this aircraft makes it capable of extended hovering and low speed operation. The arrangement of the cargo compartment is such as to offer a wide range of possibilities. Technological solutions have been adopted to ensure easy maintenance operations. Author

N67-15196# Sud-Aviation, Paris (France).
**THE SUD-AVIATION COMPOUND TURBO-ROTOR PROJECT [PROJET SUD-AVIATION DE COMBINE A TURBO ROTOR]**
*In* AGARD Helicopter Develop. 1966 p 299–315 In FRENCH; ENGLISH summary (see N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

A compound helicopter of the so-called turbo-rotor type is described which is capable of meeting inter-service requirements and offering exceptional qualities of simplicity, ease of maintenance, safety and flight handling, including during the critical transition phases. The simplicity of its design stems from the elimination of all mechanical transmission components and of the tail rotor which considerably lessens maintenance requirements. The rotor drive system is based on the ejection of the gases from two lightweight and powerful jet engines (Rolls Royce RB 189) used only for take-off, landing, and slow flying since, in high-speed flight, the rotor is autorotative. Ejection of the gases takes place at the tip of short driving arms connected to the rotor hub. In high-speed flight, propulsion is provided by two turboprops (GE T-64) or two jet engines (Lycoming PLF IB2 or BS 309). These propulsion engines are fully independent of the lift engines and operate during the whole flight. Author

N67-15197# Bolkow Entwicklungen K. G., Munich (West Germany).
**ADVANCED CONFIGURATIONS PROPOSED FOR HIGH SPEED AND/OR RANGE-ENDURANCE-PAYLOAD CONSIDERATIONS—CONTRIBUTIONS TO THE ROUND TABLE DISCUSSION**
L. Kingston and Chr. Fischer (Ver. Flugtech. Werke G.m.b.H.) *In* AGARD Helicopter Develop. 1966 p 317–325 (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

Performance improvements needed for both pure and compound helicopters are discussed along with the methods and materials for accomplishing them. The discussion covers high speed forward flight, optimization of rotor geometry, provisions for additional propulsion and wings, new systems of blade motion control, power plant improvements, empty weight reduction, reaction jet driven rotors, better lift/drag ratios for greater range, the towed glider, limitations of the pure helicopter, projects under development, and the convertible helicopter. R.N.A.

N67-15198# United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.
**LARGE ROTORS WITH MECHANICAL DRIVE**
R. B. Lightfoot *In* AGARD Helicopter Develop. 1966 p 327–348 (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

Rotor and transmission system design studies show favorable trends of weight and performance for large helicopters. Component designs developed for the 20-ton payload helicopter are compared with those in use on current models. New developments used in the designs or studied as alternative methods are discussed. Emphasis is placed on those aspects of the design in which the size of the components is used advantageously to increase the structural efficiency of the system. The influence of vehicle size on its power plant, and the integrated trends of power plant, transmission system and rotor system are used to show the interplay of benefits and penalties as aircraft size increases. Operational and human factors aspects of the use of large rotors are discussed to show how they influence the application of large helicopters for military and civilian uses. The findings of the 20-ton payload study are extrapolated to predict a 50-ton vehicle possessing several important design features still in the conceptual or development stages. Author

N67-15199# Deutsche Forschungsanstalt Fuer Luft- Und Raumfahrt, Stuttgart (West Germany).
**THE PROBLEMS OF ROTOR DRIVE AND THE FEASIBILITY OF USING VERY LARGE ROTORS WITH TIP JET DRIVES**
U. Huetter *In* AGARD Helicopter Develop. 1966 p 349–386 refs (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

Research and development work was conducted to gain experience in methods of designing and testing very large gas ducting rotors. The development of a comparatively small tip jet driven helicopter, a broad theoretical investigation, and a study of general design philosophy of large tip jet driven rotors have helped to improve knowledge in this field. To a certain extent the theoretical work as well as the interpretation of experimental results concentrated attention on the question whether "mixed cycle" or "hot cycle" would be more effective when using very large rotors with tip jet drives. In helicopters with a rotor diameter of more than 30 m the increased weight of the equipment with size would be such as to impose an unacceptable reduction in the payload. Author

N67-15201# Boeing Co., Morton, Pa. Vertol Div.
**ALTERNATIVES TO LARGE SINGLE LIFTING ROTORS**
C. W. Ellis *In* AGARD Helicopter Develop. 1966 p 401–422 (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

A review is presented of heavy lift helicopter systems based on the use both of single helicopters and of two or more helicopters

operating together (multilift). For the single helicopter case, the effect of the number of lifting rotors on rotor, drive system, and fuselage weights is reviewed. This review shows that, in addition to carrying twice the payload for any given state-of-the-art level of rotor and transmission technology, aircraft with two lifting rotors have a significantly lower weight empty (for a given payload) than other configurations considered. For the multilift case, at the same level of mission availability, multilift offers a significantly reduced system weight empty for a mission payload mix as high as 60% at sixty-ton payload and 40% at twenty-ton-payload, when compared to separate twenty- and sixty-ton-payload aircraft capable of doing the same task. Exploitation of such a system might provide a significant increase in the operational flexibility of a heavy life system at a relatively modes incremental cost. Author

**N67-15202#** Massachusetts Inst. of Tech., Cambridge. Instrumentation Lab.

**ADVANCED FLIGHT CONTROL CONCEPTS FOR VTOL AIRCRAFT**

Ralph B. Trueblood *In* AGARD Helicopter p 423-439 ref (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

(Contract DA-44-177-TC-757)

The results of a systems oriented approach to obtaining desirable handling qualities in VTOL aircraft are discussed. Major emphasis is on the hovering and low speed flight regimes. The general effects of such factors as control task, external conditions and aircraft characteristics on the flight control responses necessary to provide precision flight are considered. The desirability of ground referenced stabilization for the translational motions of the aircraft is discussed along with the system concepts necessary for a practical implementation. The operating characteristics over the complete flight spectrum of a helicopter flight control system based on these concepts is described. Author

**N67-15203#** Royal Aircraft Establishment, Farnborough (England).

**ALL-WEATHER APPROACH AND LANDING FOR HELICOPTERS**

D. F. Fance and H. B. Johnson *In* AGARD Helicopter Develop. 1966 p 441-451 (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

Investigations of helicopter handling problems during an approach and the development of guidance equipment suitable for use by VTOL aircraft are discussed. Studies into the all-weather operation of helicopters were directed toward improving the general flying characteristics by the introduction of new instrument displays and a greater used of automatic control equipment, and research into the problems of providing suitable approach aid equipment. The equipment described includes flight directors, a four channel automatic approach control system consisting of a full authority autopilot and beam coupling unit using both conventional and simulated ILS guidance, terminal navigation systems, and two approach aid techniques, a lightweight portable coded beam system and a combined terminal area navigation and final let-down aid. Equipment development has reached a stage where it is now possible to fly helicopters in poor visibility with a much improved level of safety and efficiency. R.N.A

**N67-15204#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**THE CASE FOR INHERENT STABILITY OF HELICOPTERS**

John P. Reeder, Robert J. Tapscott, and John F. Garren, Jr. *In* AGARD Helicopter Develop. 1966 p 453-472 refs (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

The nature and significance of helicopter inherent stability characteristics are discussed, including instability with angle of attack and speed static directional instability, and effective dihedral. Also covered are the use and limitations of stability augmentation systems, the requirements for acceptable inherent stability, and methods for obtaining desired inherent stability characteristics in design. Some static instabilities in forward flight encountered in helicopters without stability augmentation are dangerous and demanding of the pilot during long flights and instrument flight operations. Sophisticated augmentation systems, particularly electronic, do not have the reliability necessary for flight safety. high authority redundant systems may be desirable and necessary for such missions as low instrument approach, but if inoperative they cannot prevent a safe recovery. If the aircraft has acceptable inherent stability characteristics, cheap simple limited authority single channel systems can satisfactorily augment the aircraft's characteristics. Augmentation failure in this case does not destroy the mission capability entirely, nor the safe return to a landing. R.N.A.

**N67-15205#** Office of Naval Operations, Washington, D. C. Helicopter Anti-Submarine Squadron II.

**SPECIAL PROBLEMS IN HELICOPTER HANDLING QUALITIES AS INFLUENCED BY ANTI-SUBMARINE WARFARE REQUIREMENTS**

J. R. Williford *In* AGARD Helicopter Develop. 1966 p 473-478 (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

A helicopter pilot's requirements during an antisubmarine warfare mission, in particular the demands of an approach to a 40-ft hover on instruments, are described. Some of the helicopter flying qualities involved in the approach to, stability therein, and recovery from the hover which need improvement and suggested control and stability equipment for this purpose are outlined. R.N.A.

**N67-15206#** Royal Aircraft Establishment, Farnborough (England).

**THE RELIABILITY AND MAINTAINABILITY OF THE WESSEX HAS I HELICOPTER**

H. G. Spurr *In* AGARD Helicopter Develop. 1966 p 479-486 (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

The Wessex HAS I is a single-engined, single lifting rotor helicopter used primarily for anti-submarine duties. Its principal operational equipment includes dunking sonar, doppler radar and auto-stabilisation system. Some information is given about the contribution of the different types of sub-system and components of the Wessex to the total unreliability. A broad breakdown is given both in respect of operational reliability (mission success) and unscheduled and scheduled maintenance, for the basic air frame, for engine and mechanical systems, and for electrical and operational equipment. A lift of the worst items irrespective of system, ranked in descending order of their contribution to mission failure, and unscheduled servicing carried out in squadrons (1st and 2nd line) is given. Author

**N67-15207#** United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.

**SIKORSKY AIRCRAFT'S RELIABILITY AND MAINTAINABILITY DESIGN PHILOSOPHIES AND PROGRAMS**

E. S. Carter, Jr. and E. F. Stolper *In* AGARD Helicopter Develop. 1966 p 487-504 refs (See N67-15181 05-02) CFSTI: HC $8.81/MF $2.50

Sikorsky Aircraft's approach to reliability and maintainability is presented. Both reliability and maintainability are now treated as quantitative design disciplines with established goals on all bit and piece components. By careful comparative studies staff specialists assure that these goals are realistic. Throughout the design and development phase of the weapon system both analyses and component tests are used to confirm progress against these goals and to identify areas requiring corrective action. To put such an

approach on a realistic basis demands accurate knowledge of the reliability and maintainability achieved in the field on previous designs built to known criteria. Consequently a very large part of the reliability and maintainability effort goes into the acquisition, analysis, and feedback of field data, and we do know that we are achieving better performance in more sophisticated systems with steady improvement in overall reliability. Matured system reliability and maintenance management are being achieved much earlier in the weapon system life cycle. Author

N67-15208# Bell Helicopter Co., Fort Worth, Tex.
**DESIGNING FOR RELIABILITY USING THE UH-1 M AND R FIELD PROGRAM DATA**
James A. Gean *In* AGARD Helicopter Develop. 1966 p 505–531 (See N67-15181 05-02) CFSTI: HC$8.81/MF$2.50

The statistical approach for improvement of helicopter design by using the Maintainability and Reliability Program data is presented. Numerous statistical tables give analytic data on status of problems defined, problem identification by aircraft system, corrective action taken, economic analysis on 1000 helicopters, main failure modes of components as percentages of total component failures, overhaul components, and missions terminated unsuccessfully. R.L.I.

N67-15209# Boeing Co., Morton, Pa. Vertol Div.
**A STUDY OF THE EFFECTS OF SIMULTANEOUS DEVELOPMENT AND PRODUCTION PROGRAMS UPON MEASURED RELIABILITY**
R. B. Aronson *In* AGARD Helicopter Develop. 1966 p 533–541 (See N67-15181 05-02 CFSTI: HC $8.81/MF $2.50

The effects of minimizing the time between drawing board and field assignment on the reliability of a Boeing-Vertol military helicopter are discussed. A program of simultaneous development and production is described, in which the customer would perform much of the service testing, flight crew training, and assignment of the aircraft to field units. Future reliability efforts for the helicopter are outlined, and types of testing and analysis are mentioned. It was concluded that reliability of helicopters can be improved to the necessary level by this method if sound design practices for reliability are applied during initial design. It is pointed out that, in order to minimize the problems of the user in the field, a full developmental test cycle should be accomplished before delivery. L.E.W.

N67-15210# Boeing Co., Morton, Pa. Vertol Div.
**VIBRATION CONTROL IN ROTARY-WINGED AIRCRAFT**
D. E. Brandt *In* AGARD Helicopter Develop. 1966 p 543–567 refs (See N67-15181 05-02) CFSTI: HC$8.81/MF$2.50

The vibration phenomena associated with rotors is considered from two distinct sets of criteria: that for human factor requirements, and those associated with functional reliability and maintainability requirements, particularly structural fatigue requirements. The state-of-the-art in vibration control is discussed from the technical and financial standpoints, and proposed studies to improve vibration control technology are described from the standpoint of technical advantages, engineering compromises involved, and the magnitude of research and development programs needed for implementation. A.G.O.

# 03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N67-14715# Gulton Industries, Inc., Metuchen, N. J. Alkaline Battery Div.
**DESIGN FABRICATION OF PROTOTYPES AND TESTING OF VENTED, RECHARGEABLE SILVER-CADMIUM CELLS Interim Quarterly Report**
P. Ritterman and John Liska Ft. Monmouth, N. J., Army Electron. Command, Sep. 1966 21 p
(Contract DA-36-039-AMC-03359(E))
(ECOM-03359-I; AD-640387) CFSTI: HC$1.00/MF$0.50

The work was concerned with the development of pasted silver and pressed cadmium electrodes. Three cells, 15 ampere-hour capacity, were built using the new electrodes. Available test data show the cells with the pressed cadmium oxide electrodes to yield superior performance over the cadmium metal electrode. The two cells with the cadmium oxide electrodes performed satisfactorily when subjected to the capacity and cold temperature discharges. During the seven day charged storage test at 160F, the two cells gave 11.6 ampere-hours, just short of the 12.0 ampere-hours specified. New tests are being conducted with an improved cadmium oxide mix electrode to improve capacity after high temperature storage. Author (TAB)

N67-14716# Army Electronics Labs., Fort Monmouth, N. J.
**DRY PROCESS DIVALENT SILVER OXIDE ELECTRODES**
Nicholas T. Wilburn and Charles J. Bradley Sep. 1966 19 p ref
(ECOM-2749; AD-640053) CFSTI: HC$1.00/MF$0.50

The development of the dry process method, a new technique for fabricating divalent silver oxide (AgO) electrodes for use in zinc-silver oxide batteries, was accomplished at USAECOM and reported in AD-622 698. This report indicated that these electrodes were superior to the conventional electroformed ones in many respects such as cost, voltage regulation and discharge efficiency. Evidence was lacking, however, as to comparable mechanical strength, a strong point of the electroformed electrode and an important factor in reliability, particularly under missile environments. This report presents evidence of high mechanical strength of the dry process electrodes, sufficient for missile usage. It also presents data on an improvement in the dry process, the elimination of the sodium carboxymethylcellulose (CMC) binder, which could simplify production methods and thereby further reduce costs. Author (TAB)

N67-14720# Marquardt Corp., Van Nuys, Calif.
**INVESTIGATION OF THE CURRENT DENSITY LIMITATIONS IN A THERMIONIC CONVERTER Final Report, 1 Jan.–15 Jul. 1966**
Coleman Kaplan Aug. 1966 42 p refs
(Contract Nonr-3738(00))
(Rept.-25205; AD-639994) CFSTI: HC$2.00/MF$0.50

Transient measurements were made in a thermionic converter to investigate the ion loss mechanism at various operating conditions. A small pulsed increase in current was applied to the converter; just after the pulse an increase in output voltage was observed. The increased voltage then decayed back to the steady-state level. The time constant of the exponential voltage decay is a measure of the average lifetime of ions in the interelectrode space. The report contains an extension of the previous pulsed-discharge measurements to larger spacings and higher xenon pressures. At large electrode spacings the primary ion loss mechanism is volume recombination; at small spacings (20 mils or less) the ions are lost by diffusion to the electrodes, where surface recombination occurs. The volume-recombination lifetime decreases with increasing cesium and/or xenon pressure. The output voltage was measured for a range of spacings extending to over 200 mils, at each value of the current, cesium pressure, and xenon pressure used. It was observed that, at constant current, the output voltage is a linearly-decreasing function of the spacing, for spacings

of the order of 100 mils or larger. The decrease in the output voltage with increasing spacing is apparently due to a corresponding increase in the emitter sheath potential. This linear characteristic could prove useful in an analysis of converter theory.
Author (TAB)

**N67-14784#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**DESIGNING TWO-CASCADE COMPRESSORS**
A. M. Topunov and B. A. Tikhomirov 21 Jun. 1966 16 p refs Transl. into ENGLISH from Energomashinostr. (Moscow), no. 5, 1965 p 29–32
(FTD-AT-66-246; TT-66-62435; AD-640293) CFSTI: HC $1.00/MF $0.50

The general advantages of two-cascade compressors, the equations and the results of calculations from the selection of parameters are introduced.
Author (TAB)

**N67-14786*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**BATTERIES AND SPACE POWER SYSTEMS**
Ralph Lutwack *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 361–370 (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.00

Several research and development programs dealing with the development of heat sterlizable batteries and battery components for planetary landing capsules are discussed. These programs are concerned with investigating and developing materials, processes, and designs for a sealed heat sterilizable Ag–Zn secondary battery; fabricating and testing separator materials using polyethylene as the base film; developing new separator materials from thermostable polymers; developing a copolymer of divinyloenzene and methacrylic acid for a separator material; developing, fabricating, and testing Ag–Zn and Ag–Cd battery cells capable of functioning satisfactorily following heat sterilization, high impact, and vibration; and testing of Ni–Cd cells.
R.N.A.

**N67-14787*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**ALTERNATE APPROACHES TO STERILIZABLE POWER SOURCES**
Daniel G. Soltis *In its* Spacecraft Sterilization Technol. 1966 p 371–377 (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

The different approaches being used by a number of laboratories to develop batteries for a planetary landing capsule that can perform satisfactorily after heat sterilization are discussed along with the current status of their work. The approaches include an improved secondary Ag–Zn battery using novel sterilizable separators, an electrically regenerative hydrogen oxygen fuel cell, and Ni–Cd cells. The Ag–Zn cell must still be developed into a finished sealed cell capable of withstanding the environmental conditions of a planetary landing mission. However, there seems to be little question that this cell can withstand the rigors of thermal sterilization and perform satisfactorily. The electrically regenerative fuel cell has operated with a cycle life greater than 300 at 70° to 90°C. It has also operated at 150° and 75°C after a 150°C storage of 67 hours. Work now underway on the electrodes and membrane should enhance reliability, improve cycle life at all temperatures, and increase sterilization capability.
R.N.A.

**N67-14819*#** Fairchild Hiller Corp., Rockville, Md. Space Systems Div.
**POSITIVE DEPLOYABLE SOLAR ARRAY DEVELOPMENT PROGRAM Phase I Final Report**
Jun. 1966 91 p ref
(Contract NAS5-9658)
(NASA-CR-80917; SSD-52-6) CFSTI: HC $3.00/MF $0.75 CSCL 10A

A relatively new technique for deploying large area solar arrays has been developed that incorporates a flexible substrate to which are fastened silicon solar cells. The array can thus be packaged within a very small volume by rolling it onto a drum or reel. The design consisted of two flexible, parallel arrays, mounted on synchronized rollers, and deployed outward from a spinning body. The area of each substrate was 8 $ft^2$. Stabilization of the substrate was accomplished by an extendible scissors linkage between the arrays. Total volume of the 16 sq ft of packaged solar cells was approximately 13-1/2 pounds. An analysis of the deployment, launch, vibration, solar radiation, and induced stresses was also completed.
Author

**N67-14925*#** Bendix Corp., Southfield, Mich. Research Labs. Div.
**FABRICATION AND TEST OF A FLUERIC POSITION SERVO Progress Report, 10 Dec. 1965–10 Jun. 1966**
L. R. Erwin 10 Jun. 1966 31 p ref
(Contract NAS3-6201)
(NASA-CR-72129; BRLD-3512) CFSTI: HC $3.00/MF $0.65 CSCL 13G

A program to develop a pneumatic control drum actuator for a nuclear rocket engine in which the electronics have been replaced by fluieric devices is reported. The detailed drawings for the position error detector unit and power control valve were released. Many purchased items have been received and a number of machined parts have been completed. Improvements were made on the fluieric vortex pressure amplifiers. A breadboard lead-lag circuit was built and tested.
Author

**N67-14929*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**ANALOG-COMPUTER STUDY OF PARASITIC-LOAD SPEED CONTROL FOR SOLAR-BRAYTON SYSTEM TURBO-ALTERNATOR**
Roy C. Tew, Robert D. Gerchman, and Harbart G. Hurrell Washington, NASA, Jan. 1967 41 p refs
(NASA-TN-D-3784) CFSTI: HC $2.00/MF $0.65 CSCL 10B

An analog computer study was made of a parasitic-load speed control, which is of the type being designed for a 10-kW turboalternator of a Brayton-cycle space power system. The steady-state performance, transient response, and stability of the control system were investigated. Transients were introduced by stepping the alternator vehicle load off, allowing the system to reach steady state, and then stepping the vehicle load on. Ranges of controller parasitic-load capicity, overall gain, and time constants were studied. The simulated control with design time constants satisfied both the steady-state and the transient specifications with parasitic-load capacities equal to or greater than 10-kW for the particular transients studied. A capacity greater than 10 kW, however, should be used to provide positive control. For 12- and 18-kW capacities, the controller time constants can be several times their design values before speed response fails to meet specifications. For the 12- and 18-kW capacities, the time constants were increased until step removal of the vehicle load resulted in a sustained oscillation of the speed. Instability also occurred for design time constants but with the controller gain between 10 and 20 times the design value. Studies showed that the speed control oscillates in response to an unstable voltage regulator, but the amplitude of speed oscillations is very small.
Author

**N67-14930*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**TURBOALTERNATOR SPEED CONTROL WITH VALVES IN TWO-SPOOL SOLAR-BRAYTON SYSTEM**
Ronald L. Thomas Washington, NASA, Jan. 1967 34 p refs
(NASA-TN-D-3783) CFSTI: HC $2.00/MF $0.65 CSCL 10B

An analog computer simulation was used to study valve-speed-control methods for a turboalternator in a two-spool

solar-Brayton system. Steady-state studies of throttling and bypassing were made to determine which locations in the system could be used for the speed-control valves without causing system problems, such as operation of the compressor in the surge region or increased power drain from the heat-storage component. For the selected valve location, dynamic studies were made to determine the response requirements of the valve-actuating equipment. Finally, some of the control equipment design considerations were analyzed, such as the valve size and the estimated power requirements of the valve-actuation system. From the steady-state studies, a throttle valve at the alternator-drive turbine outlet and another valve in a bypass duct around the turbine and throttle valve were selected for the speed control. Variation of valve coefficients with valve movement must provide system flow at or slightly above the design value. If steady-state system flow and, hence, turbocompressor speed are permitted to go below the design value, good response of the turboalternator speed control is unattainable. Prohibition of overdesign power usage from the heat storage component sets the upper limit on system flow. A 6-1/2-inch butterfly valve for the throttle and a 3-1/4-inch butterfly valve for the bypass keep the system flow at or slightly above the design value. Author

**N67-14831*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**POWER SYSTEMS RELATED TO OPERATIONS OF A LANDED PLANETARY CAPSULE**
R. G. Ivanoff 1 Jun. 1965 83 p refs
(Contract NAS7-100)
(NASA-CR-80991; JPL-TM-33-238) CFSTI: HC $3.00/MF $1.30
CSCL 10B

Power sources that have been proposed for use on space capsules to be landed on the planet Mars are analyzed. The investigation was occasioned by the need to define the advantages and disadvantages of power sources that could provide power for such a landed capsule. The analysis compares the various sources on the basis of weight, operating time, development status, complexity, impact tolerance, and capability to withstand sterilization. Also included is a discussion of the thermal problems that must be considered in the design of radioisotope power systems for this mission. Author

**N67-14997#** General Motors Corp., Indianapolis, Ind. Allison Div.
**LITHIUM–CHLORINE ELECTROCHEMICAL ENERGY STORAGE SYSTEM Interim Technical Report, 13 Dec. 1965–13 Jun. 1966**
Earl H. Hietbrink, ed. 5 Jul. 1966 132 p refs
(Contract DA-44-009-AMC-1426(T))
(EDR-4669; AD-639302) CFSTI: HC $4.00/MF $1.00

The objective of the program is to obtain suitable laboratory data to determine the feasibility of a lithium-chlorine electrically rechargeable electrochemical energy storage system for vehicle propulsion. Various methods for increasing the electrochemical charge rate were investigated. At high charging current densities, the cell efficiency was found to drop significantly due to polarization of the Cl2 electrode. Experimental investigations determined that both geometry and material selection are important in the electrode design and that reverse pulsing enhances the electrode performance, allowing higher charging current density. A laboratory test cell using Li and Cl2 as reactants was fabricated to evaluate methods for increasing the electrochemical charge rate. An electrical short terminated the first cell test before meaningful data could be obtained. The required design modifications to eliminate this problem are being incorporated into the design. System analytical studies were conducted on two cell concepts. The first was an advanced concept of the Mark IV experimental cell currently being tested. The second was a cylindrical cell design using vertical electrodes. The latter cell was selected as the most advantageous and was developed into a replaceable ten-module engine system to meet the ERDL duty cycle requirements. The system is estimated to weigh 1250 lb and provide 200 kw-hr of energy. System analysis and trade-off studies on a fast charge system concept are in progress. Experimental investigations were initiated to determine the feasibility of Cl2 adsorption on charcoal. Author (TAB)

**N67-15067#** Martin Co., Baltimore, Md.
**RESEARCH PROGRAM ON APPLICATION OF JET COMPRESSORS TO MAGNETOPLASMADYNAMIC ELECTRICAL POWER GENERATION Phase II Final Technical Report, 1 Jun. 1965–31 Oct. 1966**
Walter B. Bienert 15 Nov. 1966 88 p refs
(Contract Nonr-4876(00))
(MND-3277; AD-642769) CFSTI: HC $3.00/MF $0.65

The feasibility of using jet compressors in closed cycle MPD systems was investigated. In jet compressors the thermal energy of a driving gas is converted into kinetic energy and subsequently used to compress a second gas. The thermal energy could be obtained from the residual energy of the exhaust of an MPD generator. A thermodynamic analysis of a jet compressor was made which showed that an ideal device in which both fluids mix at equal forward velocities has the same pressure ratio as a reversible engine. Theoretical expressions for the losses due to irreversible mixing of the fluids were derived. A comparison of a jet compressor system with one using rotating machinery was made. Jet compressors appear feasible, provided that a slightly lower overall efficiency can be tolerated. An experimental single stage jet compressor using cesium and helium as working fluids was built and operated. Pressure ratios up to 1.48 of the helium were measured which correspond to approximately 90% of the theoretical value. The experimental compression work was over 50% of that of a reversible engine. It is estimated that in a large, optimized system 80–90% of the reversible compression work can be obtained. Author (TAB)

**N67-15305#** Catholic Univ. of America, Washington, D. C. Dept. of Mechanical Engineering.
**TESTING OF GAS TURBINE HIGH VELOCITY DUCT SYSTEMS Final Scientific Report, 1 Sep. 1964–31 Aug. 1966**
William J. Kelnhofer and Russell A. Smith 31 Aug. 1966 200 p refs
(Contracts NObs-92176; NObs-86550)
(AD-640070) CFSTI: HC $5.00/MF $1.25

A study is made of incompressible and subsonic compressible (up to Mach number = 0.4) flow losses associated with intake and exhaust ducting components and systems for shipboard boiler-turbine and gas turbine engines. An extensive literature survey is made to determine what design data are available and the areas where more design data are needed. A mathematical model covering one-dimensional diabatic and adiabatic gas flow is presented. Good comparisons are obtained between the model and laboratory tests for circular and square cross-sectional ducts with Mach numbers up to 0.4. Based on additional tests, new design data are presented in three areas: Reynolds number effects on short-radius elbow pressure loss coefficients, subsonic Mach number at which compressibility effects on the elbow pressure loss coefficient begins, and how the position of an elbow in a system affects its pressure loss coefficient. Using data found in the literature and the new data mentioned above, a design data sheet for shipboard engine ducting systems is evolved. A good comparison is obtained between losses calculated using the design data sheet and a limited number of model systems tested in the laboratory. Author (TAB)

# 04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N67-14373# Library of Congress, Washington, D. C. Aerospace Technology Div.

**HEMODYNAMIC INDICES DURING THE ACTION OF SUPER-HIGH FREQUENCY ELECTROMAGNETIC FIELDS**

Surveys of Foreign Scientific and Technical Literature

Sheila Panners 5 Oct. 1966 8 p refs Transl. into ENGLISH from Gigiena Truda i Prof. Zabolevaniya (Moscow), no. 7, 1966 p 18–21

(ATD-66-123)

Hemodynamic indices as minute blood volume, peripheral resistance, average and actual arterial pressure, and the degree of tonic strain in the smooth muscle of various vessels were recorded using a mechanocardiograph in order to determine the effect of super high frequency radiation on the human cardiovascular system. Data obtained showed that exposure to SHF of considerable intensity not only causes pathological changes in the nervous system, but brings about deviations in the functional state of the circulatory system as well. In the clinical picture of patients with moderate and pronounced symptoms of SHF exposure, neurocirculatory disorders with a tendency to hypertension were dominant. Analysis of pulse-wave velocity in myogenic and elastic type vessels, of the elasticity modulus, and of the ratio between the elastic moduli of the two types of vessels indicated that the elasticity of the walls of myogenic type vessels increases during all stages of chronic exposure to SHF electromagnetic fields. Data on peripheral resistance showed increased resistance in the precapillary system, and EKG analysis revealed changes in intra-cardiac conductivity and sinus bradycardia, due apparently to disturbances in the extracardiac regulation of cardiac activity. Although a firm correlation between hemodynamic disorders and pathological deviations due to SHF exposure could not be established, changes in hemodynamic indices were found to occur much more frequently in subjects with moderate and pronounced symptoms of exposure. S.C.W.

N67-14375# Joint Publications Research Service, Washington, D. C.

**PRINCIPLES OF CONTROL SCIENCES APPLIED TO FIELD OF BIOLOGY AND MEDICINE**

5 Dec. 1966 35 p Transl. into ENGLISH from Nauka i Tekhn. (Riga), No. 8, Aug. 1966

(JPRS-38959; TT-66-35382) CFSTI: $2.00

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3. USE OF LINEAR CORRELATION METHODS IN VARIOUS SCIENCES I. Rabinovich p 10–16 (See N67-14378 05-04)

4. EFFECTS OF CHEMICALS ON MENTAL PROCESSES DESCRIBED I. Lapin and Yu. Nuller p 17–27 (See N67-14379 05-04)

N67-14376# Joint Publications Research Service, Washington, D. C.

**FEEDBACK IN A COMMUNITY OF ORGANISMS**

G. Sabardina *In its* Principles of Control Sci. Appl. to Field of Biol. and Med. 5 Dec. 1966 p 1–5 (See N67-14375 05-04) CFSTI: $2.00

A discussion of inherent problems associated with disturbing the life and development of symbiotic associations of plants and animals with their environment is presented. Emphasized is the importance of the self-regulating mechanism of living organisms which is realized with the help of feedback acting from the output to the input. The essence of this feedback includes the fact that part of the synthesized organic matter (in the form of droppings subject to the effect of microorganisms, and in the form of primordium of living plants) being converted into resources of one and the same community, insures it further life and development. The advantages of understanding such associations between living organisms and their environment are discussed in view of their importance to: (1) The formation of methods for controlling the development of biocoenosis which are based on an understanding of those mechanisms which may have a regulatory significance; (2) The determination of the fertility and productivity of forests, farm lands, and reserves of natural resources; and (3) The development of controlled methods for transplanting new plant forms and introducing new breeds of domestic animals into environments which are foreign to their native habitats. S.C.W.

N67-14377# Joint Publications Research Service, Washington, D. C.

**MODERN MATHEMATICS AND BIOLOGY**

L. Rastrigin *In its* Principles of Control Sci. Appl. to Field of Biol. and Med. 5 Dec. 1966 p 6–9 (See N67-14375 05-04) CFSTI: $2.00

Problems associated with the reluctance of biologists to adopt mathematical methods in biological theory and practice are discussed. Difficulties in the formalization of biological objects and the specificity of modern mathematics are considered the primary causes underlying the prejudice of biologists against modern mathematics. The applicability of divisions of modern mathematics which may be used by biologists such as the theory of adaptation, the probability theory, the extrapolation theory, and their divisions; are discussed. It is concluded that modern mathematics has at its disposal resources which may be used by biologists and medical men. These resources are quite strong and effective and they cannot be neglected. Inadequate use of these divisions of modern mathematics by medicine and biology leads to intolerable expenditures of efforts and resources. On the other hand, biology needs a special mathematics which would be more adaptable to the description of the behavior of biological systems. Both problems may be solved only by timely symbiosis of mathematics and biology. This symbiosis at the present time must be considered the most progressive form of existence both of biology and mathematics. S.C.W.

N67-14378# Joint Publications Research Service, Washington, D. C.

**USE OF LINEAR CORRELATION METHODS IN VARIOUS SCIENCES**

I. Rabinovich *In its* Principles of Control Sci. Appl. to Field of Biol. and Med. 5 Dec. 1966 p 10–16 (See N67-14375 05-04) CFSTI: $2.00

The use of the method of least squares by mathematicians for determining the relationship between a set of given values based on data from observations is discussed. Emphasized is the need for nonmathematicians, such as animal breeders, to consider the question of probability when dealing with problems of cause and effect. It is further noted that in the problem of cause and effect it is impossible to rely on the correlation coefficient since in most cases the assumption of a so-called linear dependency between the variables drops out. The need for a better understanding of the principles, language, and limitations of mathematics by the nonmathematician is also emphasized. S.C.W.

N67-14379# Joint Publications Research Service, Washington, D. C.

**EFFECTS OF CHEMICALS ON MENTAL PROCESSES DESCRIBED**

I. Lapin and Yu. Nuller *In its* Principles of Control Sci. Appl. to Field of Biol. and Med. 5 Dec. 1966 p 17–27 (See N67-14375 05-04) CFSTI: $2.00

Problems related to testing the effect of new psychotropic drugs on human mental processes on the basis of studies of the emotional reactions of laboratory animals are discussed. It is surmised that although it is possible on the basis of psychopharmalogical tests to propose one effect or another of a new compound on the human mind, the final word belongs to research performed on the mentally ill. It is further noted that: (1) The positive effect of the medicine frequently depends not so much on its chemical effect as on the belief of the patient in it; that is, in the final analysis on factors of suggestion and autosuggestion; and (2) It is necessary to treat people not only with tablets but also with kind words, concern, attentiveness, and it is also necessary to win their confidence if a good medicine is to be effective. S.C.W.

N67-14381# Joint Publications Research Service, Washington, D. C.

**ELECTRONIC AIDS FOR THE PHYSICIAN**

M. L. Bykhovskiy et al 8 Dec. 1966 47 p refs Transl. into ENGLISH of the Book "Elektronnyye Pomoshchniki Vracha: Problemy Biologicheskoy Kibernetiki" Moscow, Znaniye Publishing House, 1966 p 1–43
(JPRS-30923; TT-66-35446) CFSTI: $2.00

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N67-14382# Joint Publications Research Service, Washington, D. C.

**INTRODUCTION**

V. V. Parin *In its* Electron. Aids for the Physician 8 Dec. 1966 p 1–3 (See N67-14381 05-04) CFSTI: $2.00

Reasons are given for presenting the cybernetics approach to the study of vital processes. Also given is a discussion of what this approach has to offer the theory and practice of biology and medicine. Such areas as control in organisms, transient states, biological regulation, and process simulation are considered in discussing some general assumptions of physiological cybernetics. C.T.C.

N67-14383# Joint Publications Research Service, Washington, D. C.

**THE UNION OF CYBERNETICS AND BIOLOGY**

A. A. Malinovskiy *In its* Electron. Aids for the Physician 8 Dec. 1966 p 4–11 (See N67-14381 05-04) CFSTI: $2.00

A discussion is given of the role cybernetics plays in the study of biology. Emphasis is placed on the concept of direct communications and feedback in order to regulate the course of a process. Examples are given which show the significance of the corpuscular structure of systems of evolution. C.T.C.

N67-14384# Joint Publications Research Service, Washington, D. C.

**BIOCURRENTS IN THE SERVICE OF MEDICINE**

V. S. Gurfinkel *In its* Electron. Aids for the Physician 8 Dec. 1966 p 12–18 (See N67-14381 05-04) CFSTI: HC $2.00

Electrical phenomena in humans are discussed along with biopotential control systems and various apparatus using this phenomena. The operation of a prosthesis for the forearm is described in which the control unit is operated by biopotentials from amputated muscles. Other areas discussed include instruments controlled by biopotentials from the heart and apparatus for investigating consciousness during electrographic paroxysms in patients with epilepsy. C.T.C.

N67-14385# Joint Publications Research Service, Washington, D. C.

**A MACHINE MAKES THE DIAGNOSIS**

M. L. Bykhovskiy *In its* Electron. Aids for the Physician 8 Dec. 1966 p 19–24 (See N67-14381 05-04) CFSTI: $2.00

A computerized cybernetics method for diagnosis of a disease and presenting an optimum plan of action is discussed. The logical steps that the process utilizes are described along with the medical memory, processing of the information, and the self training processes. It is noted that the system is especially applicable to diagnosing congenital defects in the heart, mechanical jaundice, acquired heart defects, and certain infectious diseases. C.T.C.

N67-14386# Joint Publications Research Service, Washington, D. C.

**IS IT POSSIBLE TO SIMULATE CONSCIOUSNESS AND FEELING?**

A. G. Spirkin *In its* Electron. Aids for the Physician 8 Dec. 1966 p 25–37 refs (See N67-14381 05-04) CFSTI: $2.00

A philosophical approach is used in discussing the possibility of simulating consciousness and emotion. The principle of feedback in cybernetics is shown applicable, in that certain general laws inherent in animate organisms, organs, cells, communities of biological species, and society may be reproduced with technical devices. C.T.C.

N67-14397# Joint Publications Research Service, Washington, D.C.

**ISOTOPES AND IONIZED RADIATION AS POWERFUL TOOLS OF SCIENTIFIC RESEARCH**

Kiril Popov 5 Jan. 1967 4 p Transl. into ENGLISH from Zemedelsko Zname (Sofia), 4 Dec. 1966 p 2
(JPRS-39418; TT-67-30068)

A discussion is presented of the uses of isotopes and ionized radiation in the fields of biology, agriculture, and medicine. Various accomplishments are cited, and mention is given to the production facilities and laboratories conducting research. C.T.C.

N67-14399*# Oregon State Univ., Corvallis.

**SYSTEMATIC DESCRIPTION OF BACTERIAL ISOLANTS FROM RIGOROUS ENVIRONMENTS**

W. B. Bollen 30 Sep. 1966 6 p Prepared for JPL
(Contracts NAS7-100; JPL-950783)
(NASA-CR-80871) CFSTI: HC $1.00/MF $0.50 CSCL 06M

Results are presented of ammonification and nitrification tests of desert soils. Ammonium liberated by hydrolysis and oxidation-reduction of added peptone after three days and five days incubation was used as an index of ammonifying power. It was found that all soils except one were active in this heterotraphic function, being comparable to representative agricultural soils. On incubation with ammonium sulfate for 30 days, only two soils showed a nitrifying power comparable to representative cultivated soils. C.T.C.

N67-14486*# Weizmann Inst. of Science, Rehovoth (Israel). Polymer Dept.
**MECHANOCHEMISTRY**
A. Katchalsky and A. Oplatka *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 73–97 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75
(Grant AF-EOAR-62-58)

Some general rules are reviewed for mechanochemical conversion (the transformation of mechanical into potential energy). A mathematical discussion is presented for the reversible conversion of chemical free energy into mechanical work. Equations are derived for elementary work cycles and the characterization of a mechanochemical field. Also discussed are: the change of chemical potential with length in a closed system, the enrichment of a fiber in equilibrium with an open bath, the conversion of chemical into mechanical energy during contraction in an equilibrium bath, the chemical melting and enrichment of contractile fibers, and mechanochemical rate processes. R.Ll.

N67-14488*# Osaka Univ. (Japan). Dept. of Biology.
**RHEOLOGY OF CYTOPLASMIC STREAMING**
Noburo Kamiya *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 105–121 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

Descriptions were given of some basic features of rheological importance of the cytoplasmic streaming in the slime mold (Physarum polyoephalum), e.g., flow profile, spontaneous change in flow velocity, the motive force responsible for the flow and its rhythmic variation, the twisting habit of the slime mold strand, etc. Techniques applied by the author for studying each of these characteristics were also described in some detail. Author

N67-14558*# California Univ., Berkeley. Dept. of Nutritional Sciences.
**BEHAVIOR OF *PEROGNATHUS* Semiannual Progress Report, 1 Jul.–31 Dec. 1966**
31 Dec. 1966 6 p
(Grant NGR-05-003-118)
(NASA-CR-80893) CFSTI: HC $1.00/MF $0.50 CSCL 06C

The development of a pelleted diet consisting of sunflower meal and millet is described in relation to studying the nutritional requirements of two subspecies of Perognathus (Longimembris and Penicillatus). A climatron is described, which was obtained to study breeding behavior by subjecting mice to seasonal changes they would experience in the field. Finally, in order to obtain baseline values for future studies, organ weights, carcass composition, and certain blood values of a group of P. penicillatus were determined. L.E.W.

N67-14561*# New York Medical Coll., N. Y.
**PROCEEDINGS OF THE FOURTH INTERNATIONAL CONGRESS ON RHEOLOGY. PART 4: SYMPOSIUM ON BIORHEOLOGY**
Alfred L. Copley, ed. New York, Interscience, 1965 656 p refs Congr. held at Brown Univ., Providence, 26–30 Aug. 1963
(Grant NsG-509)
(NASA-CR-80868) CFSTI: HC $9.55/MF $2.75 CSCL 06P

Symposium papers on laminar flow of biological fluids, cytoplasmic streaming, hemolysis, sap movement, hemorheology of pulsatile flow, blood flow in branching and tapered tubes, biorheological measurements and observations, hemorheology of redcell suspensions, medical biorheology, in vivo hemorheology in man and animals, biorheology of tissue materials, and blood clotting and low shear hemorheology are presented. For individual titles see N67-14562–N67-14608.

N67-14562*# New York Medical Coll., N. Y. Dept. of Physiology and Pharmacology.
**OPENING ADDRESS ON THE VALIDITY OF CLASSICAL FLUID MECHANICS IN BIORHEOLOGY**
Alfred L. Copley *In its* Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 3–10 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The Opening Address consists of three parts. The first part is a brief survey of the events pertaining to the organization of the symposium on biorheology. The second part refers to Heraclitus and other pre-Platonic thinkers, the founders of the natural sciences, and their insights into nature as related to modern rheology. In the third part, which deals with the topic of the address, phenomena, in which an apparent deviation of fluid mechanics exists, are mentioned to point out the complexity of the rheology of certain biological fluids in vivo and extra vivo. Examples are the plasmatic zone, free of red and white blood cells, in the living circulation and the observation that the apparent viscosity of blood systems in capillary viscometers can be altered by coating the glass surface with different substances. A possible explanation for the latter phenomenon could be the existence of slip along the wall, an assumption which is rejected in classical fluid mechanics. As an alternative explanation, it is surmised that no slip exists, if there is wall adherence in a closed system. However, wall adherence has only been established on the basis of an index of blood systems bordering air surfaces and traveling in a capillary tube. Author

N67-14563*# Uppsala Univ. (Sweden).
**ARCHAIC HEMORHEOLOGY. THE EARLY HISTORICAL SIGNIFICANCE OF BLOOD SEDIMENTATION**
Robin Fahraeus *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 11–17 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Pathology of the ancient Greeks was founded on observations of the blood. The contents of the venous system seemed to be a mixture of four fluids, which separated more or less when the mixture had left the warm body. One could thus distinguish the black bile, the yellow bile, the blood (in the limited sense of the word), and the phlegm. The properties of the last-named fluid had the greatest influence on the conception of diseases. In normal blood the phlegm was invisible but served as the connecting substance in the caked blood. In diseases, on the contrary, the phlegm formed a more or less thick layer at the top of the caked blood. This phenomenon was a consequence of increased blood sedimentation but was taken by the Greeks as proof that the phlegm had increased in amount, a change of the contents in the veins much more ominous, as the phlegm in contradistinction to the other three fluids had the property to congeal and make the contents of the vessels immovable. The fever was nature's means of counteracting this tendency. Venesection was considered by the physicians as the most effective way of reducing the predominance of phlegm. Author

N67-14564*# Royal Institution of Great Britain, London.
**RESEARCH IN HEMORHEOLOGY, INTRODUCTORY LECTURE**
K. Weissenberg *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 19–33 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Research in hemorheology can form an integral part of Einstein's concept of research in an all-embracing natural science. In that science one aims to fit experiment and theory to one another as closely as possible and over the widest possible range of conditions, while one takes fully into account the inevitable uncertainty and arbitrariness of all experimental data. The theory here eliminates the defects of the experimental data for wider and wider changes of materials, conditions, and modes of observation by way of the group theory of transformations and invariants, and

thereby makes it possible to approach step by step to the ideal of obtaining a perfect fit between experiment and theory as between lock and key. Author

**N67-14565*#** Reading Univ. (England). National Inst. for Research in Dairying.

**SOME ASPECTS OF RHEOLOGICAL THEORY AS APPLIED TO BIOLOGICAL SYSTEMS**

G. W. Scott Blair *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 35–44 refs (See N67-14561 05-04) CFSTI: HC$9.55/MF$2.75

Although the same fundamental mechanical laws apply to all rheological systems, certain treatments are more appropriate than others for studying biological phenomena. Following the parallel of rheology and thermodynamics, it is suggested that the new irreversible thermodynamics will be of special value for studying processes in vivo. Classical elasticity theory, though useful enough for a few structural materials such as bone, is hardly suited, even as extended by recent workers, to most biological systems. It is proposed that the mathematics of quantum theory, leading to a new type of invariant, concerned rather with processes than with properties, would be worth careful consideration. Author

**N67-14566*#** Institut Pasteur, Paris (France). Service de Biophysique.

**CONGLOMERATION PROVOKED BY FLOW IN MACROMOLECULAR SOLUTIONS OF BIOLOGICAL ORIGIN [AGREGATION PROVOQUEE PAR L'ECOULEMENT DANS LES SOLUTIONS DE MACROMOLECULES D'ORIGINE BIOLOGIQUE]**

M. Joly *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 45–68 refs In FRENCH (See N67-14561 05-04) CFSTI: HC$9.55/MF$2.75

The general principles of aggregation kinetics in flow are reviewed, and the characteristic behavior of globular or ellipsoid particle suspensions is described. This behavior depends on the relative values of shearing velocity, initial particle size, and interaction energy. For a given system (sizes and interaction energies of particles of specific values), there are successive shearing velocities, and the flow effect on the dispersion of suspended particles is of a different type. Examples are given and it is shown that, despite the schematic character of the models used, there is satisfactory agreement between experimental results and theoretical expressions on the variation of average size of aggregates as a function of the shearing velocity. Some applications of the interaction energy are also included. Transl. by R.U.

**N67-14567*#** Nottingham Univ. (England).

**AN APPLICATION OF PARTICLE FLUID MECHANICS TO BLOOD FLOW**

R. L. Whitmore *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 69–82 refs (See N67-14561 05-04) CFSTI: HC$9.55/MF$2.75

The observed fall in blood viscosity and erythrocyte concentration, when the diameter of a glass capillary down which the blood is flowing is decreased, is frequently attributed to the presence of a cell-free layer at the tube wall. Experiments show that under suitable conditions individual particles, flowing near a wall, may move away from it but when a mass of particles is present an opposing dispersive pressure is also developed. From published results on the flow of suspension of spheres in tubes the parameters indicating the conditions for spheres to leave the wall are derived. On applying them to data on the flow of blood in glass capillaries it is shown that normally the outwardly directed dispersive pressure is many times greater than the inward pressure developed by the erythrocytes. Thus the existence of a "plasmatic layer" at the wall of a capillary tube down which blood is flowing is unlikely, and the layer which is observed in vivo must be the product of some other interaction or force. Author

**N67-14568*#** McGill Univ., Montreal (Quebec). Dept. of Chemistry.

**PHYSICAL ASPECTS OF THE FLOW OF BIOLOGICAL SUSPENSIONS THROUGH TUBES**

H. L. Goldsmith and S. G. Mason *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 85–88 refs (See N67-14561 05-04) CFSTI: HC$9.55/MF$2.75

The steady laminar flow of liquid suspensions of rigid and deformable particles through rigid tubes has been investigated by direct observations of the particle motions through a travelling microscope. The phenomena studied in the first part of the work included the rotation of single small rigid spheres, rods, and discs; the radial migration of rigid and deformable spheres; and particle interactions in dilute and concentrated suspensions. The second part describes the flow and deformation of large liquid bubbles suspended in wetting liquids undergoing Poiseuille flow. Author

**N67-14569*#** Tokyo Metropolitan Univ. (Japan).

**THEORETICAL CONSIDERATIONS ON THE FLOW OF BLOOD THROUGH A CAPILLARY**

Syoten Oka *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 89–102 refs (See N67-14561 05-04) CFSTI: HC$9.55/MF$2.75

Scott Blair has shown that an equation proposed by Casson for varnishes and which was later applied by Steiner to molten chocolate, gives excellent straight lines for bovine, rabbit, and human blood, on both glass and fibrin surfaces. Following this equation, straight lines are obtained when the square root of the shear rate is plotted against the square root of the shear stress. On the assumption that Casson's equation is applicable to blood, we treated theoretically the rheological behavior of blood flowing in a capillary. We have obtained both the velocity distribution across the capillary and the volume of flow in unit times as a function of pressure difference. The result was compared with the rheological behavior of a Bingham system and other non-Newtonian systems. Author

**N67-14570*#** Cartiera Vita Mayer E.C., Milan (Italy). Sezione Ricerche.

**NECKLACE-LIKE FORMATIONS IN THE POISEUILLE FLOW OF A SUSPENSION OF SPHERES**

Giorgio Segré *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 103–118 refs (See N67-14561 05-04) CFSTI: HC$9.55/MF$2.75

Experiments on the rearrangement of spherical particles carried in a dilute suspension in Poiseuille flow are presented. The tendency of the particles to form regular groups (necklaces) aligned parallel to the tube axis is established and is analyzed photographically. It is shown that this tendency increases with the particle diameter, and that the observed distribution of groups agrees with an interpretation based on nearest neighbor hydrodynamic interaction. In the stable configurations the gap between the particles is a function of the number of particles in the group, independent of the particle diameter, and strongly correlated with the Reynolds number. A comparison with von Karman's theory on vortex systems is made, but no correlation results. Author

**N67-14571*#** Weizmann Inst. of Science, Rehovoth (Israel).

**HYDRODYNAMIC INTERACTION BETWEEN PARTICLES IN SUSPENSION**

A. Silberberg *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 119–124 refs (See N67-14561 05-04) CFSTI: HC$9.55/MF$2.75

The importance of theoretical models for the understanding of biorheological phenomena was stressed, and the central position of the hydrodynamic interaction tensor in these considerations underscored. The use of this tensor for studies of the concentration dependence of specific viscosity was examined, and it could be shown that the Huggins coefficient for a class of models based on statistical assemblies of connected spheres should be identical with that of the hard sphere case. Deviations can be interpreted as due to specific interactions. Author

**N67-14572*#** Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Mechanics.

**A FORMULATION OF THE PROBLEM OF FLOW THROUGH TUBES**

E. A. Fox and Edward Saibel *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 125–133 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The equations of motion of a general fluid in an extensible tube are put in a form suitable for calculating flow from quantities which may reasonably be measured. These are the cross-sectional area of the tube, its time derivative and the derivative along its length. From these quantities, information regarding the flow rate and the axial force can be obtained. The equations are developed in terms of net axial force and thus obviate a fluid constitutive equation. Before meaningful calculations can be made the constitutive relations in the wall must be determined by experiment *in vivo*. The equations lend themselves to such experiments. The equations developed include inertia and body forces and are suitable for calculations of flow in deformable tubes. Author

**N67-14573*#** Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.

**THE CASSON EQUATION AND RHEOLOGY OF BLOOD NEAR ZERO SHEAR**

E. W. Merrill, W. G. Margetts, G. R. Cokelet, and E. R. Gilliland *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 135–143 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

As a continuation of previous studies this paper is concerned with assessing the relevance to blood rheology of the model upon which N. Casson derived the equation

$$\tau^{1/2} = S\gamma^{1/2} + b$$

where $S = [\eta_0/(1-H)^{\alpha s}-1]^{1/2}$; $b = [(\alpha\beta)/(s\alpha-1)][(1-H)^{1-\alpha s/2}-1]$; $\tau$ is the shear stress, $\gamma$ the shear rate, $\eta_0$ the viscosity of suspending medium, $H$ the volume fraction of dispersed particles, $s$ the factor depending on average orientation of aggregate, and $\alpha,\beta$ the constants. On the one hand, the *form* of the equation serves well in correlating the low shear rate data on blood near and at zero shear. On the other hand, the model on which the equation is based does not allow for attraction between, or three-dimensional structural organization of, the rodlike aggregates (rouleaux). The applicability of the Casson equations to the rheology of human blood is discussed. Author

**N67-14574*#** Osaka Univ. (Japan). Dept. of Biology.

**THE VISCOELASTICITY OF SLIME MOLD PROTOPLASM**

Shigemi Abe *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 147–155 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

By analyzing a damped oscillation shown by the plasmodial strands, elasticity and viscosity values of the slime mold protoplasm were determined independently of each other. On the basis of the type of deformation caused by the application and release of a torque, it is found that rheological behavior of the same mold protoplasm can be well represented in terms of a four-element model. Each of these elasticity and viscosity values were determined. When a torque was applied on a plasmodial strand repeatedly at short intervals, it was observed that the strain corresponding to each torque increased progressively indicating that the slime mold protoplasm is thixotropic in nature. Author

**N67-14575*#** Osaka Univ. (Japan). Dept. of Biology.

**ROTATIONAL PROTOPLASMIC STREAMING IN *NITELLA* AND SOME PHYSICAL PROPERTIES OF THE ENDOPLASM**

Noburo Kamiya and Kiyoko Kuroda *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 157–174 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

From the velocity distribution of rotational streaming in the *Nitella* cell is was concluded that this type of streaming is driven by an active shearing force generated at the endoplasm-ectoplasm boundary. By means of a suitable technique the endoplasm can be isolated out of the cell in comparatively large drops which can survive more than 24 hr, *in vitro*. The density of the naked endoplasmic drops is from 1.014 to 1.015 g./cm.$^3$; tension at the surface is from 0.002 to 0.004 dyne/cm. The isolated endoplasm can flow under an adequate pressure gradient if it is properly introduced into an agar capillary. There is no indication that artificially induced flow under pressure gives rise to any harmful effect. The velocity profile of the endoplasm in a circular capillary represents a plug dow. From the velocity gradient of the intracapillary flow of endoplasm apparent viscosity of the endoplasm was measured under different shear stresses; it is 250 cp. when shear stress is 4.3 dyne cm.$^2$. Apparent viscosity increases rapidly as the shear stress becomes smaller than 1.5 dyne/cm.$^2$. Author

**N67-14576*#** Chicago Univ., Ill.

**BROWNIAN AND SALTATORY MOVEMENTS OF CYTOPLASMIC GRANULES AND THE MOVEMENT OF ANAPHASE CHROMOSOMES**

Edwin W. Taylor *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 175–191 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The viscosity of cytoplasm in cultured cells of the newt (*Triturus viridescens*) was estimated from measurements of Brownian motion of granular components. The average viscosity was about 300 cp., but it varied considerably from cell to cell. In addition to Brownian movement granules were occasionally seen to undergo saltatory displacements of several microns in a few seconds. These displacements cannot be accounted for as Brownian movements unless they occur in local regions with a viscosity at least one hundred times smaller than the average. From a knowledge of the viscosity, the mechanical work in saltatory and chromosomal movements was estimated. Neither type of movement appeared to depend on particle size or cell viscosity. From considerations of the general character of the movements and approximate calculations of the power that can be generated it is concluded that the movements cannot be produced by thermal, electrical, hydrodynamic, or diffusion fields. It is suggested that saltatory movements arise from interaction with motile cytoplasmic filaments. The mechanism of filament movements and the presence of a countercurrent stream in the fluid adjacent to the filaments is discussed in terms of the propagation of waves along the filaments. Author

**N67-14577*#** Yeshiva Univ., New York. Dept. of Pediatrics.

**FLOW PROPERTIES OF HEMOGLOBIN IN THE HEMOLYSING RED CELL**

Joseph A. Kochen *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 193–202 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

In order to visualize the outward flow of hemoglobin from individual red cells, the emerging hemoglobin was complexed with Alizarin Red S. This resulted in the formation of steadily lengthening streams of precipitated extruded intracellular material which

remained attached to the red cell ghosts at the sites of membrane breakdown. Hypotonic hemolysis induced by a sudden decrease in the ionic strength of the surrounding medium resulted in the extrusion of a single stream of hemoglobin from each lysing red cell. By assuming that the diameters of the extruded streams were essentially the same as the diameters of the membrane defects through which the hemoglobin emerged, and by relating these values to the critical red cell volumes, fading times and proportional hemoglobin loss, it was possible to compute the diffusion coefficient of hemoglobin in the lysing red cell. These studies suggest that sudden osmotic hemolysis is preceded by an influx of extracellular fluid which results in swelling of the red cell and a dilution of its hemoglobin content. The increase in red cell volume leads to the formation of a single microscopic region of complete membrane breakdown through which the intracellular hemoglobin escapes by a process of free passive diffusion. Author

N67-14578*# London Univ. (England). Dept. of Physiology.
**THE FLOW PROPERTIES OF BLOOD AS A FACTOR IN THE STABILITY OF PULSATILE FLOW**
D. A. Mc Donald *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 205–213 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The applicability of concepts determining the transition from laminar to turbulent flow, which are based on studies of steady flow, is discussed in relation to the oscillatory flows found in the circulatory system. While transient breakdowns of laminar flow occur at relatively low Reynolds' numbers, there is some evidence that there may be increased stability with regard to sustained turbulence. The distributon of rates of shear and inflections in the velocity profiles that occur in pulsatile flow are considered in relation to this problem, together with probable changes due to the inhomogenous character of the blood. Author

N67-14579*# Itek Corp., Palo Alto, Calif. Vidya Div.
**A STUDY OF AUSCULTATORY BLOOD PRESSURES IN SIMULATED ARTERIES**
Alvin H. Sacks, K. R. Raman, and Jack A. Burnell *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 215–230 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

After an analysis of the pulsatile viscous flow in flexible tubes, a large-scale pulsating flow system was constructed and various simulated arteries of 1 in. diam. were tested over wide ranges of pulse rate, pressure level, and pulse pressure using, first, various mixtures of water and glycerol and, finally, whole steer blood as the fluid. The oscillatory intra-arterial pressures were recorded by pressure transducers attached to both static and total pressure probes in the flow itself, and these are compared with the systolic and diastolic pressures which were obtained by the clinical auscultatory technique, using a stethoscope and a specially designed pressure chamber. In addition, simultaneous measurements were made of arterial wall displacements and the velocity of the pulse wave along the tube. The simulated system has exhibited many of the qualitative features of a living human subject, and the entire spectrum of characteristic Korotkoff sounds was produced in the artery. The test results indicate that the auscultatory systolic and diastolic pressure readings are consistently higher than the corresponding maximum and minimum of the oscillatory intrarterial pressures by an amount which depends on the stiffness and thickness of the arterial wall. Author

N67-14580*# Massachusetts Inst. of Tech., Cambridge. Dept. of Nutrition and Food Science.
**DIMENSIONAL ANALYSIS OF PULSATING BLOOD FLOW, AN INTRODUCTION**
W. McComis, S. Charm (Tufts Univ., Boston), and G. Kurland (Harvard Univ.) *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 231–242 refs Prepared in Cooperation with Tufts Univ. and Harvard Univ. (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

A detailed consideration is made of the equations of motion for pulsatile flow of a non-Newtonian fluid through cylindrical tubes and the usual assumptions made in obtaining a solution. In view of the fact that the assumptions necessary to reduce the theoretical equations to a solvable form are unrealistic for flow of blood through small tubes, the authors suggest dimensional analysis as a method for obtaining equations which describe the pressure-velocity relationships. Author

N67-14581*# Kanematsu Memorial Inst., Sydney (Australia). Dept. of Research.
**PLASMA SKIMMING IN HUMAN BLOOD FLOWING THROUGH BRANCHING GLASS CAPILLARY CHANNELS**
A. A. Palmer *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 245–255 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Partial plasma skimming (i.e., unequal distribution of cells and plasma) was found consistently when human blood with anticoagulants flowed through branching glass channels, of dimension 200 $\mu$ or less in the plane of branching, whenever the rate of flow from the branches was unequal or if the arrangement of the branches was such that there was unequal distribution of axial and peripheral blood. Results with channels which divided into three branches were in good agreement with these assumptions; however, when less than about one-seventh of the total flow passed into any one branch the results became inconsistent probably because of eddy formation. Hence, although complete plasma skimming never occurred, the possibility that there was a narrow cell-free plasma zone near the wall cannot be excluded. Partial plasma skimming was greatest at the lowest shear rate tested; it fell as the apparent shear rate at the wall as increased to about 20 $sec.^{-1}$ and thereafter remained at an almost constant level as the shear rate was further increased. The addition of high molecular weight dextran to the blood greatly increased partial plasma skimming. Author

N67-14582*# Royal Institution of Great Britain, London.
**DEVELOPMENT OF INSTRUMENTATION FOR THE TESTING OF EXTRACORPOREAL FLOW AND DEFORMATION OF BIOLOGICAL MATERIALS**
K. Weissenberg *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 261–266 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The development of an instrument is discussed which allows testing of the mechanical shear properties of a material over wide ranges of conditions by taking goniometric measurements of the distributions of the movements and forces in space and time. Author

N67-14583*# Liverpool Univ. (England). Dept. of Civil Engineering.
**A NEW CAPILLARY-TYPE VISCOMETER**
R. B. Whittington and John Harkness (Musgrove Park Hosp., England) *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 267–279 refs Prepared in Cooperation with Musgrove Park Hosp. (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The general U tube viscometer is analyzed, and the conditions for unidirectional or oscillatory flow are derived. Ostwald's viscometer, as a unidirectional instrument, is analyzed. A new pressurized instrument is compared with the Ostwald. The question of true absolute determination is discussed. There are some observations on non-Newtonian measurements and on intrinsic viscosity. Author

N67-14584*# Kobayashi Inst. of Physical Research, Tokyo (Japan).
**A NEW CAPILLARY VISCOMETER FOR MEASURING THE VISCOSITY OF SMALL AMOUNTS OF BLOOD**
Heiji Kawai, Eiichi Fukada (Inst. of Phys. and Chem. Res.), Takayoshi Ibe, and Hisao Shono (Rion Co., Ltd., Tokyo) *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 281–297 refs Prepared in Cooperation with the Inst. of Phys. and Chem. Res. and Rion Co. (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

A graduated glass tube is closed at the top and bottom with two syringe needles and held in a vertical position. A negative pressure is produced within the glass tube by releasing a compressed rubber ball joined to the upper side of the tube. The air and liquid to be tested are drawn through the top and bottom capillaries, respectively, into the glass tube. Maximum height of liquid thus drawn in measures the value of viscosity within the accuracy of 4%. The volume of liquid required is only 0.3 ml., and the measuring time is less than 10 sec. The viscosity of whole blood as a function of hematocrit and the viscosity of plasma as a function of protein contents have been studied. The viscosity of venous blood in a dog has been measured *in vivo* by inserting the needle of the viscometer into the external jugular vein. Variation of viscosity with the injection of aqueous solution of glucose has been observed. Author

N67-14585*# Goteborg Univ. (Sweden). Surgical Dept. I.
**RHEOLOGICAL DISTURBANCES FOLLOWING TISSUE INJURY**
Lars-Erik Gelin *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 299–315 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Tissue injury induces a decreased fluidity of blood especially at lower rates of shear. The decreased fluidity is caused by increased hematocrit, increased viscosity of plasma, and an additional factor called "viscosity-plus factor." The viscosity-plus factor accelerates with decreasing rate of shear, increasing hematocrit, and increasing vehicle viscosity. Decreased fluidity of blood is of especial importance for the venous return and for the postcapillary flow where there is a low pressure head and a low flow rate. An increased viscosity of blood means by itself a threatening stagnation. Hemodilution with agents able to reduce viscosity, especially at low rates of shear, has resulted in remarkable improvements in severe clinical conditions. Author

N67-14586*# California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science.
**STREAMING BIREFRINGENCE STUDY OF THE INTERACTION OF SUBMICROSCOPIC RODS AND SPHERES**
H. Wayland and Marcos Intaglietta *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 317–335 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

A streaming birefringence apparatus using Faraday cell modulation and photoelectric detection is described. This apparatus was capable of angle of isocline measurement to $\pm 1°$ for a retardation of 0.5 A. and retardation measurements of 0.3 A. This apparatus was used to study the streaming birefringence of mixtures of rodlike particles 3000 by 180 A. (tobacco mosaic virus) and 250 A. diam. spherical particles (southern bean mosaic virus). With constant amounts of rods (0.3%) the specific retardation of the system first dropped and then increased with the addition of the spherical particles with a minimum at 0.5% spheres. Possible explanations are discussed. Author

N67-14587*# Rochester Univ., N. Y.
**THE INFLUENCE OF ELECTROKINETIC CHARGE ON THE RHEOLOGICAL PROPERTIES OF RED BLOOD CELL SUSPENSIONS**
Harold A. Cox, Jr. and Gouq-Jen Su *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 337–350 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Suspensions of human erythrocytes in various isotonic media were studied by means of coaxial cylinder viscometry (from 400 to 1800 $sec^{-1}$) and microelectrophoresis to determine whether or not a relationship existed between the electrokinetic charge on the cells and the rheological behavior of the suspensions. It is shown that the electrokinetic charge does not play a dominant role in controlling suspension flow behavior under normal conditions in this shear rate region. This was demonstrated through experiments using albumin solutions, normal serum, isotonic sucrose, and an isoantibody solution as suspending media. Reasons are given why a charge-flow relationship in these suspensions could be expected under other conditions, such as very low shear rates. The addition of a polyvalent cation to the system is capable of decreasing cell mobility to such an extent that the viscosity increases significantly, as was demonstrated with $AlCl_3$ in physiological saline. Author

N67-14588*# Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Civil Engineering.
**THE PROFILE VISCOSITY AND OTHER CHARACTERISTICS OF BLOOD FLOW IN A NON-UNIFORM SHEAR FIELD**
George Bugliarello, Chandra Kapur, and George Hsiao *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 351–370 ref (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The phenomenon and features of blood flow are investigated in detail, with capillaries in the vertical position so as to eliminate the asymmetries in the flow pattern caused by sedimentation, which had been shown to affect significantly the results in the horizontal layout). Velocity profiles, determined by averaging over the whole useful duration of the film the velocities of erythrocytes observed at fixed radial stations, were nearly axisymmetrical in all cases, as expected from the absence of settling effects. Although determination of the experimental viscosity profiles is subject to a considerable degree of uncertainty, the occurrence of off-center viscosity peaks at the higher hematocrits suggests a concentration effect caused by a concurrent drift of the erythrocytes from the walls and the centerline toward an intermediate radial position. The axial symmetry of the average flow permitted the more accurate measurement of the peripheral layer characteristics (thickness, standard deviation), and from them the determination of the average concentration in the cell-rich core of the flow. S.P.

N67-14589*# London Univ. (England). St. Mary's Hospital Medical School.
**THE DIFFERENCE IN CIRCULATION TIMES BETWEEN ERYTHROCYTES AND PLASMA *IN VIVO***
S. Rowlands, A. C. Groom, and H. W. Thomas (Reading Univ.) *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 371–379 refs Prepared in Cooperation with Reading Univ. (See N67-1456 05-04) CFSTI: HC $9.55/MF $2.75

Evidence is presented that *in vivo* the red cells have a shorter circulation time than the fluid constituents of blood. A mechanism which would explain the shorter circulation time of cells is discussed. Author

N67-14590*# Reading Univ. (England). National Inst. for Research in Dairying.
**THE FLOW OF RED CELL SUSPENSIONS THROUGH NARROW TUBES: THE (EXTRACORPOREAL) DETERMINATION OF THE DIFFERENCE IN MEAN VELOCITIES OF RED CELLS AND THEIR SUSPENDING PHASE**

H. W. Thomas, R. J. French, A. C. Groom, and S. Rowlands (London Univ.) *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 381–396 refs Prepared in Cooperation with London Univ. (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

A small but significant difference in the mean circulation times of red cells and plasma flowing through various circulatory beds in experimental animals and in human subjects has been frequently reported in the scientific literature. In order to try and elucidate the mechanism of this phenomenon, simultaneous measurements have been made of the circulation times of radioactive labeled red cells and albumin injected into a red cell suspension flowing through an artificial bed of 26 nylon tubes of 200 $\mu$ bore connected in parallel. The observed clearance curves for the labeled red cells and albumin were markedly different, and there was a significant difference in mean circulation times. Author

N67-14591*# Goteborg Univ. (Sweden). Dept. of Surgery.
**RHEOLOGICAL DISTURBANCES AND THEIR TREATMENT IN CLINICAL SURGERY**
Bengt Zederfeldt *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 397–410 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

It has been shown that tissue injury of different kinds is followed by changes in the physical properties of blood with increased viscosity, especially at low rates of flow, marked changes in the capillary circulation with stagnation in postcapillary vessels as a dominant finding. This leads to decreased venous return and metabolic disturbances. Low viscous dextran is one agent able to improve the capillary blood flow when this flow is decreased by changes in the physical properties of blood and thereby improves the tissue nutrition. Author

N67-14592*# Hamburg Univ. (West Germany). First Medical Clinic.
**HEMORHEOLOGICAL INVESTIGATIONS IN THE "ARTERIAL SPIDERS" OF THE HUMAN SKIN**
Harald Harders *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 413–424 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The "arterial spider" of the human skin is a suitable model for hemorheological studies in man by immediate accessibility of a terminal arterial vascular tree under unusually high pressure by the use of cantharide blisters. The central arteries may have inner diameters up to several hundred microns and are visible in their connections with the arterial branches, the capillary network, and collecting venous net. Direct microscopical observation under high magnification of flow characteristics and behavior of streaming cells, micromanipulation, and pressure recordings are possible. The morphology of the vascular spiders is described with emphasis on unusual vascular formations as spiral arteries and abrupt changes of inner vascular diameter. Functional and rheological findings and pressure recordings are discussed, which show systolic arterial pressures exceeding 100 mm. Hg and dropping abruptly within the course of few millimeters. Under clinical conditions the arterial spiders are a valuable sign in chronic liver disease. They do not constitute a localized vascular abnormality but are part of a widespread structural and functional transformation of the whole peripheral vascular bed. This transformation is, e.g., expressed by palmar erythema and changes in the terminal vascular bed of mucous membranes, skin, and finger tips. The origin and the purpose of such universal microvascular rearrangement in liver diseases are still unknown. Author

N67-14593*# Massachusetts Eye and Ear Infirmary, Boston. Microcirculatory Lab.
**BIOLOGICAL REACTIONS INTERFERING WITH FLOW THROUGH THE MICROCIRCULATION**
John W. Irwin and Dolores C. Alcaide *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 425–430 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Methods to study the pulmonary microcirculation of living rabbits have been presented. Changes in both the caliber of these vessels and in the fluidity of the blood flowing through them have been noted during anaphylaxis, histamine shock, and serotonin shock. Pharmacological doses of epinephrine also markedly affect the flow of blood through the pulmonary microcirculation. It is suggested that studies in rheology must take into account the capacity of the microscopic pulmonary blood vessels to change their calibers rapidly and the fact that the consistency of blood is not necessarily constant. Author

N67-14594*# Harvard Univ., Boston, Mass. Dept. of Medicine.
**THE EFFECTS OF PLASMA PROTEINS UPON THE RHEOLOGY OF BLOOD IN THE MICROCIRCULATION**
Roe E. Wells, Jr. *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 431–438 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Each of the three major fractions of the plasma proteins has a different effect upon suspension stability and viscosity. The changes observed *in vitro* do not always correlate with those observed *in vivo*. Both globulin and fibrinogen cause cell aggregation but as globulin exists at 3 to 4 times the concentrations of fibrinogen it accounts for the major viscosity effects of the two fractions. Albumin inhibits cell aggregation and reduces viscosity. Cell aggregation *in vivo* may lead to reduced or stagnant flow, and conversely, stagnant flow in the presence of increased fibrinogen or globulin may lead to profound cell aggregation. The integrity of cell aggregates increases with increasing fibrinogen or globulin levels which may withstand the excursion from the venous system through the larger vessels to eventually occlude the arteriolar system. Author

N67-14595*# Cambridge Univ. (England). Anatomy School.
**VISUAL PARTICLE VELOCITY MEASUREMENT IN FLUID STREAMS**
P. A. G. Monro *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 439–449 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The principles of methods for measuring the velocities of flowing blood cells are discussed. A description is given of a prototype instrument designed to measure directly very slow blood cell velocities seen in small veins as well as the much faster velocities (up to 5 mm./sec.) seen in arterioles in the rabbit ear chamber and in the everted hamster cheek pouch. A more compact eyepiece visual velocity measuring instrument is also described. This may be exchanged for the eyepiece of an ordinary monocular microscope and is more convenient for measuring the very much higher velocities (up to $10^5$ times their diameter per second) of blood cells or other particles caused to flow in fine glass tubes. The appearances of blood flowing at high velocities in fine blood vessels are discussed. These indicate that flowing blood in the larger arterioles contains loose aggregates of red cells separated by zones of relatively cell-free plasma. Author

N67-14596*# Erlangen Univ. (West Germany). Medical Clinic.
**FLOW PATTERN PERTAINING TO VASCULAR PERMEABILITY AS OBSERVED BY FLUORESCENCE VITAL MICROSCOPY**
Siegfried Witte *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 451–458 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The intravascular blood flow forms the basis of an undisturbed vascular permeability. Of special interest is the behavior of macromolecular material especially of the plasma proteins. Visibility

of these proteins may be achieved by fluorescent labeling and observation by fluorescent microscopy (rat mesentery). The spreading of the labeled material after passing the wall of the terminal vessels was demonstrated. Two different forms of spreading in the perivascular tissues may be distinguished. Normally, tiny capilliform fluorescent streaks arranged in a network will develop. This phenomenon would be compatible with a flow along a pre-formed system. If permeability is increased pathologically, the extra vascular fluid will spread in a diffuse cloudy manner. The velocity of spreading of fluorescent material was determined. Maximal flow rate occurs for the dye penetrating from capillaries (3 $\mu$/sec.). The lowest values are found around arterioles. In cases of increased vascular permeability, spreading velocity reaches maximal values around all sections of the terminal vascular bed. These investigations of the streaming interstitial fluid will give access to a new field of biorheology. Author

N67-14597*# Goteborg Univ. (Sweden). Dept. of Anatomy.
**INTRACAPILLARY RHEOLOGICAL PHENOMENA**
P-I. Branemark *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 4 1965 p 459-473 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Intracapillary flow phenomena, the shape and behavior of the blood corpuscles when passing the capillary system, their relation to one another and to the endothelial wall are described and illustrated microphotographically on the basis of direct microscopic observations of living tissue capillaries in animals and man. The complexity of capillary structure and function is demonstrated. The examples of capillary rheology described and illustrated might form a basis for further calculations and analysis in attempts to understand capillary function. Author

N67-14598*# University Coll., London (England). Dept. of Physiology.
**SOME MECHANICAL PROPERTIES OF COLLAGENOUS FRAMEWORKS AND THEIR FUNCTIONAL SIGNIFICANCE**
R. D. Harkness and Margaret L. R. Harkness *In* N. Y. Med. Coll. Proc. on the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 477-488 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Examination of the mechanical properties of the uterine cervix, the narrowest part of the birth canal in the rat, gives evidence that two factors are involved in the change which takes place in pregnancy to allow the birth of the mature fetus: an increase in the natural circumference of the collagenous framework, and an increase in its extensibility under tension. This property was measured by the ratio of the rate K of extension, when this had become constant under constant load, to length $l_0$ at zero time obtained by extrapolation, the figures so obtained being corrected to a standard tension per unit cross-sectional area of collagen, calculated for length $l_0$ from the total collagen content of the sample. No increase in pregnancy was found in the extensibility of the uterus itself. A similar examination of rat's skin showed a marked drop (80 times) in extensability with age associated with a rise in tensile strength. Thus there appears to be a change in the properties of the collagenous framework of the skin increasing the surface mechanical resistance more than would be expected from change in collagen content, which, per unit area, also increases with age. Some properties of the skin of an animal, the hippopotamus, with peculiarly high surface mechanical resistance are discussed. Author

N67-14599*# Sydney Univ. (Australia). Dept. of Medicine.
**RHEOLOGY OF SYNOVIAL FLUID AND ITS ROLE IN JOINT LUBRICATION**
Leopold Dintenfass *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 489-503 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The theories of lubrication were reviewed, and it was concluded that neither the classical hydrodynamic theory nor the boundary theory permits an adequate description and explanation of lubrication in synovial joints. It is suggested that the key factor is the thixotropic behavior of synovial fluid which enables preserving constant load-bearing capacity at various rates of movement. The elastic properties of the articular cartilage might depend on the presence of synovial fluid in its pores. The pressure exerted in the fluid will depend on the elasticity of the cartilage and on the area of contact. The velocity gradient in the gap will depend on the normal and lateral deformations in the articular cartilage. Pathorheology (rheological pathology) of the synovial joints is discussed and related to physicochemical and morphological changes in both synovial fluid and cartilage. The proposed outline of lubrication in synovial joints explains the interdependence of synovial fluid and articular surfaces. Both synovial fluid and articular cartilage are necessary components of joint lubrication. Author

N67-14600*# New York Medical Coll., N. Y. Dept. of Biochemistry.
**FACTORS AFFECTING THE RHEOLOGICAL BEHAVIOR OF HYALURONIC ACID**
Ward Pigman, G. Matsumura, and A. Herp *In its* Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 505-519 refs Supported by Public Health Service (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The rheological characteristics of hyaluronic acid are markedly dependent upon many substances found in tissues and fluid. They are markedly affected by the presence of salts, pH, natural autooxidants, anti-oxidants, and oxygen. Three-dimensional networks (semigels) are formed which, considerable evidence shows, could affect the movement of large molecules including the diffusion of proteins. The gel structure of the intracellular ground substance of connective tissue is probably provided by hyaluronic acid and seems to be highly dependent upon the degree of polymerization. Since the gel structure influences the mobility, variations in gel structure may provide a mechanism of control of permeability of metabolites moving to and from cells and capillaries. Author

N67-14601*# Commonwealth Scientific and Industrial Research Organization, Sydney (Australia). Wool Research Labs.
**STRUCTURAL TRANSITIONS IN NATIVE COLLAGEN AND THEIR PHYSIOLOGICAL SIGNIFICANCE**
B. J. Rigby and P. Mason *In* N. Y. Med. Coll. Proc. on the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 521-534 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Four structural transitions in collagen are considered, viz., the shrinkage temperature $T_s$, at which a specimen shrinks abruptly to about one-quarter of its original length; the melting temperature $T_m$, which is the true thermodynamic melting point of the crystalline system and may be 10°C. or more below $T_s$; the glass transition temperature $T_g$, which is lower than $T_m$ and which marks an abrupt increase in the thermal expansion coefficient; and finally the denaturation temperature $T_D$, which is the temperature at which collagen molecules in dilute solution undergo the transition from helices to random coils. Measurements of $T_s$ and $T_g$ are described and discussed in relation to partial premelting of the specimens, the effects of swelling in water, and the influence of prolonged mechanical strain. The bulk transition $T_g$ is the only one of the transitions which occurs in the vicinity of normal body temperature and may be closely involved in the pathology of collagenous structures. It is suggested that the effects of such factors as swelling, pH, amino acid composition; and mechanical loading, which have already been studied in relation to $T_s$, should not be examined in relation to $T_g$. Author

N67-14602*# Laboratorium fuer Polarisationmikroskopie, Bremen (West Germany).

**OPTICAL POLARIZATION OF SPINNING THREADS OF THE VITREOUS BODY OF ANIMAL EYES AS AN EXPRESSION OF THEIR BIORHEOLOGICAL BEHAVIOR [POLARISATION-SOPTIK AUS DEM GLASKOERPER TIERISCHER AUGEN GESPONNENER FAEDEN ALS AUSDRUCK IHRES BIO-RHEOLOGISCHEN VERHALTENS]**

Hans H. Pfeiffer *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 535–546 refs In GERMAN; ENGLISH summary (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Three effects of thread-shaped deformation of the vitreous humor of animal eyes were qualitatively and quantitatively studied in polarized light: the flow birefringence, the double absorption or dichroism, and the double diffraction. For each case, an attempt was made to interpret the behavior of the spinning threads by assuming the orientation theory within its limitations. Author

N67-14603*# College Scientifique Universitaire de Tours (France). Lab. d'Hematologie.

**THE THROMBODYNAMIC PROPERTY OF A CLOT: THE SPECIFIC HEMORHEOLOGICAL PROPERTY EXPLORED BY THE THROMBELASTOGRAPH (THE THROMBODYNAMIC FUNCTION OF PLAQUETTES, FIBRIN, AND CERTAIN FACTORS OF PLASMA AND SERUM) [LA PROPRIETE THROMBODYNAMIQUE DU CAILLOT: PROPRIETE HEMO-RHEOLOGIQUE SPECIFIQUE EXPLOREE PAR LE THROM-BELASTOGRAPHE (LA FONCTION THROMBODYNAMIQUE DES PLAQUETTES, DE LA FABRINE ET DE CERTAINS FACTEURS DU PLASMA ET DU SERUM)]**

Maurice E. Laroux *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 549–569 refs In FRENCH (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

The specific hemorheological property of blood clots was studied by Hartert's thromboelastograph. This is called a thrombodynamic property because it shows the physiological ability of clots to remain in equilibrium *in situ* with intravascular pressure during hemostasis because of their rigidity and parietal adherence. The property develops progressively during structuration of the clot by fibrin, factor XIII, calcium, platelets, and other serological factors. The thrombodynamic function of platelets is essential and includes all vital activity during hemostasis. The structural evolution of the clot depends on the result of the antagonistic syneresis forces off fibrin, and of the retraction of the platelets. Transl. by R.Ll.

N67-14604*# Heidelburg Univ. (West Germany).

**CLOT RETRACTION. KINETICS AND CORRELATION WITH THE CLOTTING PROCESS**

H. Hartert *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 571–580 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Retraction of the blood clot consists apparently of a chemical phase, which brings about a strain in the clot. Retraction (i.e., the physical phase of retraction) takes place after chemical tightening of the clot. The moment when it begins depends on the process of detachment at the interface between clot and surface of the container. The speed of retraction depends on the volume of the clot and on the number of blood cells, provided a normal amount and quality of fibrinogen as well as platelets are present. Roughly speaking, the yield is determined by the same factors. The physical potency of retraction remains active for several hours after clotting, yet decreases progressively. After 4 hours, e.g., it still has two-thirds of its initial value. The chemical phase of retraction seems to be identical with that phase of the clotting process in which the fibrin and platelets containing clot structure is established. Author

N67-14605*# Goteborg Univ. (Sweden).

**FAT EMBOLISM–A HEMORHEOLOGIC DISTURBANCE**

Sven-Erik Bergentz *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 581–592 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

Posttraumatic fat embolism is generally assumed to be caused by intravasation of major fat droplets from traumatized fat tissue, particularly the bone marrow. Fat embolism is, however, a relatively common phenomenon even without a mechanical injury. In experimental animals fat embolism can be produced in different ways, including the initiation of an intravascular coagulation process, for instance by injection of thromboplastic substances. Evidence is given to show that the posttraumatic fat embplism can be caused by a hemorheologic disturbance with a change in the physical state of the fat normally occurring in the blood. This change is probably due to an intravascular coagulation process initiated by the trauma. Author

N67-14606*# Sydney Univ. (Australia). Dept. of Medicine.

**A STUDY IN RHEOLOGY OF BLOOD CLOTTING IN HUMAN SUBJECTS**

Leopold Dintenfass *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 593–600 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

A study of blood clotting was carried out by means of a cone-in-cone rotational viscometer. Blood samples were obtained from healthy persons and from patients suffering from anaemia, coronary infarction, venous thrombosis, leukamia, rheumatoid arthritis, polycythemia, and cancer. Also blood from a sheep was employed. Clotting of blood was made apparent by a viscosity increase. The rate of clotting depended not only on the origin of the sample but also on the velocity gradient at which such clotting took place. At body temperature, clotting proceeds more rapidly at higher velocity gradients. Author

N67-14607*# Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.

**INFLUENCE OF PLASMA PROTEINS ON THE RHEOLOGY OF HUMAN BLOOD**

A. Britten (Mass. Gen. Hosp.), Robert B. Pennell (Protein Found., Boston), E. W. Merrill, W. G. Margetts, G. R. Cokelet et al *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 601–611 refs Prepared in cooperation with Mass Gen. Hosp. and Protein Found. (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

By means of a viscometer, further studies were made on the role of fibrinogen and the other plasma proteins in the rheology of blood measured near and at zero shear. These studies include correlation of the rheological parameters (including yield stress) with the measured fibrinogen content of numerous samples of normal human blood and blood from a patient with afibrinogenemia and comparison of the rheological properties of suspensions of red cells in the Cohn fractions. Author

N67-14608*# Columbia Univ., New York. Coll. of Physicians and Surgeons.

**VISCOSITY OF BLOOD AT LOW SHEAR RATES: OBSERVATIONS ON ITS RELATION TO VOLUME CONCENTRATION AND SIZE OF THE RED CELLS**

Magnus I. Gregersen, Branko Paric, Shu Chien, Duncan Sinclair, Chen Change et al *In* N. Y. Med. Coll. Proc. of the 4th Intern. Congr. on Rheol., Pt. 4 1965 p 613–628 refs (See N67-14561 05-04) CFSTI: HC $9.55/MF $2.75

(Contract DA-49-193-MD-2272)

In vitro tests on haparinized blood from elephant, man, dog, and goat revealed species differences in the blood viscosity at low rates of shear. These differences may be related to the

mean corpuscular volume of the red cell, although species differences in the plasma may also play a role. Similar, though less pronounced, results were obtained for red cells suspended in Ringer's solution. Author

N67-14635*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**COMMUNICATIONS BIOPHYSICS**
M. B. Sachs *In its* Res. Lab. of Electron. 15 Oct. 1966 p 159–164 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25
(Contract DA-36-039-AMC-03200(E); Grants NSF GK-835; NIH G-MH-04737-06)

A quantitative description is given of the responses of auditory nerve fibers to two-tone stimuli. A single variable, i.e., rate of spike discharge, is used for this description. Iso-rate contours for responses to one-tone stimuli were constructed by means of a sweep-frequency technique. When rate was measured as a function of the frequency of one of two tones, that tone was presented as a sweep-frequency signal. If a second tone was present, it was presented as a continuous tone at the fiber's characteristic frequency. Data were collected for testing mathematical descriptions of responses by using tone-burst stimuli and measuring the discharge rate after the transient at the tone-burst onset. By this method, expressions were developed to describe the relationship between discharge rate and the stimulus parameters of the two-tones. K.W.

N67-14636*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**NEUROPHYSIOLOGY**
R. Moreno-Diaz, W. F. Pickard, B. Howland, and Stephen J. Wiesner (Brandeis Univ.) *In its* Res. Lab. of Electron. 15 Oct. 1966 p 165–178 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25
(Contract AF 33(615)-3885; Grant NIH G-NB-04985-03)

Presented are three articles, the first of which discusses stability of networks with loops, specifically: (1) the state transition matrix of a neural network, (2) network stability and oscillations, and (3) stability for a single neuron. The second article is a brief summary of two impalement techniques for use in studying the electrical properties of myelinated fibers in the dorsal roots of cats. The third article describes a method for fabricating large-aperture sphero-cylinder lenses. The method depends on the deformation of square plates by couples of forces applied at opposite corners. The advantage of this method is that the forces involved are self-equalized and need be applied at only four points. Included is a discussion of test methods for plastic-cast crossed-cylinder lenses and the use of a crossed-cylinder lens to test camera lenses. K.W.

N67-14703# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE CEREBRAL CORTEX AND THE FUNCTION OF THE VESTIBULAR APPARATUS**
E. Sh. Ayrapet'yants and V. A. Kislyakov 29 Jul. 1966 53 p refs Transl. into ENGLISH from Kora Bol'shikh Polushariy i Funktsiya Vestibulyarnogo Apparata, An SSSR (Moscow), 1962 p 1–4, 604–619
(FTD-TT-66-30; TT-66-62447; AD-640313) CFSTI: HC $3.00/MF $0.50

The basic theories and works of Rudolph Magnus are reviewed, and questions arising from his work are considered. Factual material accumulated in the Soviet Union during three decades relating to the problem of the cerebral cortex and the function of the vestibular apparatus is presented with an extensive bibliography. Alterations in vestibular reactions after extirpation of the cerebral cortex and with various influences on it are discussed, and the question of localization of the cortical terminus of the vestibular analyzer is considered. The study of the cortical regulation of vestibular reactions according to the method of conditioned reflexes is also assessed. L.E.W.

N67-14734# School of Aerospace Medicine, Brooks AFB, Tex.
**EXPERIMENTAL INVESTIGATIONS WITH ELECTRICAL STIMULATION OF THE OCULOMOTOR NUCLEUS: THE EFFECTS OF STIMULUS FREQUENCY Interim Report, Sep. 1962–Jun. 1964**
Donald G. Pitts Jul. 1966 17 p refs
(SAM-TR-66-65; AD-639640) CFSTI: HC $1.00/MF $0.50

Procedures and methods for the study of the central control of accommodation by electrical stimulation are presented. Positive accommodation, an increase in the dioptric power of the eye, and negative accommodation, a decrease in the dioptric power of the eye, were found by brain-stem stimulation in the cat. The frequency threshold for positive accommodation was about 4 cps. The frequency threshold for negative accommodation was about 10 cps. Frequencies of 60 and 90 cps were more efficient in producing positive accommodation, while negative accommodation varied directly with the frequency up to the 120 cps limiting frequency. The central control of accommodation by the oculomotor nucleus appears to depend somewhat on the stimulus frequency. Not all responses can be explained by frequency alone, and a definitive theory must await further data and analysis. Author (TAB)

N67-14765*# National Aeronautics and Space Administration, Washington, D. C.
**NASA REQUIREMENTS FOR THE STERILIZATION OF SPACECRAFT**
Lawrence B. Hall et al *In its* Spacecraft Sterilization Technol. 1966 p 25–39 ref (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

Decontamination requirements for lunar landing spacecraft are reviewed, in which primary reliance for decontamination is placed on the die-away of microorganisms over a period of time. To meet the more rigorous requirements for sterilization of planetary landing capsules, the general plan includes four major phases: (1) development of sterilizable capsule hardware; (2) limitation of the quantity of viable biological loading; (3) application of terminal sterilization; and (4) protection of the sterile capsule from recontamination through launch. Several alternative methods of limiting the viable burden on a capsule are discussed. These include clean handling throughout; heat decontamination of parts, and clean subassembly; and heat decontamination before clean final assembly. The broad NASA sterilization guidelines for planetary landing hardware are listed; however, it is pointed out that such guidelines are undergoing constant reevaluation and adjustment. M.G.J.

N67-14766*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**STERILIZATION AND QUARANTINE PARAMETERS FOR CONSIDERATION DURING THE DESIGN OF PLANETARY VEHICLES**
Charles W. Craven, Joseph J. Mc Dade, and Jay O. Light *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 43–50 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

The tentative policy adopted as a constraint on all launches for Mars is outlined, and the known sources of contamination are summarized. Capsule sterilization procedures, based on chemical decontamination and exposure to dry heat, have been selected as optimum, and steps taken to insure the development of sterilizable materials and components are discussed. Although heating to 135°C for 24 hours has proved adequate, the possibility is mentioned that a lower temperature for a longer time may be selected for

the flight programs. Sterilization is aimed at the inactivation of all microorganisms, in particular the fungi and bacteria; problems connected with their destruction are discussed. It is expected that all subsystems, including the various science payloads, will be subjected to one chemical decontamination cycle (ethylene oxide), and one dry heat sterilization cycle as part of the flight acceptance test before the start of final assembly. Capsule assembly and sterilization procedures are depicted. M.G.J.

N67-14767*# Minnesota Univ., Minneapolis. Dept. of Environmental Health.
**ENVIRONMENTAL MICROBIOLOGY AND THE CONTROL OF MICROBIAL CONTAMINATION**
Joseph J. McDade (JPL), Martin S. Favero (Public Health Serv.), George S. Michaelsen, and Donald Vesley *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 51–86 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

Levels of microbial contamination have been presented for the intramural environments of 17 different facilities located in three geographical areas of the United States. The data obtained indicate that a well run clean room can and does reduce the level of intramural microbial contamination. Such studies also have shown that the primary source of microbial contamination in a clean room is the operating personnel. Soil-type species, such as bacterial and mold spores, did not appear prevalent in the total population of microorganisms recovered within the clean rooms sampled in this survey. Elimination of microbial contaminants such as spores is of critical importance in obtaining sterility by dry heat, or at least in increasing the reliability that a given sterilization procedure successfully will meet the NASA planetary quarantine requirements. Consequently, these preliminary data indicate that use of a clean room environment for assembly of space hardware has merit. Author

N67-14768*# Mayo Clinic, Rochester, Minn.
**SKIN CARRIAGE OF BACTERIA IN THE HUMAN**
John A. Ulrich *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 87–95 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

Several techniques required to assess the bacterial population on and in the skin are discussed. Areas of high and low density of bacteria on the skin are found. The pattern of spread is common in all normal individuals and no sex differences have been observed. Each person maintains a level of population within a limited range and climatic changes appear to have little or no influence on the level. Methods such as scrubbing and flushing and the use of germicides can cause a temporary reduction in numbers, but there is a rapid return to normal levels. Mechanical barriers still remain the best method to handle sterile objects. Author

N67-14769*# Public Health Service, Washington, D. C. Communicable Disease Center.
**QUANTITATIVE ASPECTS OF SHEDDING OF MICRO-ORGANISMS BY HUMANS**
Dick K. Riemensnider *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 97–103 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

In order to study shedding of all microorganisms from people, a stainless steel chamber large enough to accommodate a standing adult was constructed. This chamber, called a microbiotank, was designed to permit sterilization by steam prior to occupancy by the subject to be evaluated, and to facilitate easy recovery of organisms shed into it. The techniques developed for these quantitative investigations are described, and details are presented on the test procedures used. Data are given to show the total viable particles shed by individuals at various exposure times in the microbiotank, and the consistency of microbial shedding from individuals on consecutive days. It was concluded that good personal hygiene plus the wearing of sterile clothes reduces the numbers of microorganisms shed into the environment. M.G.J.

N67-14770*# Army Biological Labs., Fort Detrick, Md.
**MICROBIOLOGICAL BARRIER TECHNIQUES**
G. Briggs Phillips *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 105–135 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

The types of microbiological barrier techniques and equipment that could be useful in solving spacecraft sterilization problems are defined and illustrated. The five stages of microbiological contamination control are listed as (1) recognize and define the problem; (2) establish contamination control criteria; (3) employ approaches and techniques of control; (4) use microbiological testing and surveillance; and (5) analyze results and certification procedures. The importance of each is discussed. Microbiological barrier systems are classified according to purpose, size, and degree of containment, and specific examples of each are given. Recommended sterilization and decontamination agents for each barrier application are listed. Advantages and disadvantages are assessed, with emphasis focused on heat, vapors and gases, liquid decontaminants, and radiation. Recommended conditions of use for such agents are summarized, and certain desirable minimum features for the microbiological barriers are listed. M.G.J.

N67-14771*# Minnesota Univ., Minneapolis.
**VISUAL MONITORING AS AN ASSAY TECHNIQUE**
R. Angelotti, K. H. Lewis (Public Health Serv.), and D. W. Drummond *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 137–146 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

The applications of visual monitoring to microbiological contamination control during spacecraft assembly, test, and launch are discussed in the context of a complete monitoring system. It is pointed out that such monitoring is needed to assure both operational reliability and contamination control. As an example, the microbiological monitoring of milk production is discussed to illustrate the place of such techniques in a successful commercial operation. The needs for exchanges of information between functional groups are stressed, and mechanisms are indicated by which such problems can be solved. Although most monitoring can be performed by nonprofessional personnel, the recommendation is made that a professional microbiologist visual observer be present in the spacecraft handling area. M.G.J.

N67-14772*# Minnesota Univ., Minneapolis. School of Public Health.
**SURVEY OF MICROBIOLOGICAL TECHNIQUES FOR RECOVERY FROM SURFACES**
Donald Vesley *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 147–153 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

Standardized methodology is being developed for several applications of microbial surface sampling in the spacecraft sterilization effort. Surface evaluations will include: (1) room surfaces in assembly areas (Rodac and swab methods), (2) clothing and packaging materials (Rodac method), (3) stainless-steel strips to determine cumulative contamination over an extended period in assembly areas (rinse method), (4) piece part evaluation (rinse and direct agar plating methods), and (5) subsystems evaluation (rinse and direct agar plating methods on detachable coupons designed into the system). In particular, the combination rinse and direct agar plating technique appears to be a valuable tool for quantitative and qualitative evaluation of microbial loading prior to terminal sterilization. Author

N67-14773*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**MICROBIOLOGICAL TECHNIQUES FOR RECOVERY FROM INTERIORS OF SOLIDS**
Earl G. McNall, William T. Duffy (Dyn. Sci. Corp.), and John J. Iandolo *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 155–176 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

The need for developing adequate pulverization techniques for exposing microorganisms within solids is discussed, along with the necessity for developing methodology to overcome the adverse environments provided by the entrapping solids. The widely different forms of pulverization produced by various blade and tooth conformations of saws are described, and tabulated data are presented to show the effect of pressure and blade designs on the pulverization of plastic materials. Solid rocket propellants are considered the most difficult spacecraft component to pulverize; however, polyester and epoxy resins can be satisfactorily pulverized by sawing. Techniques for leaching, neutralization, and culture of certain solid spacecraft materials are also discussed. M.G.J.

N67-14774*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**DEVELOPMENT OF A BIOLOGICAL INDICATOR FOR DRY-HEAT STERILIZATION**
Alexander S. Irons et al *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 177–189 (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

The indicator system will consist of a spore tablet, a sealed carrier or container, and a handling procedure designed to prevent inadvertent contamination of the space hardware being assayed. It will be capable of discerning, biologically, the attainment of the conditions considered necessary to sterilize space hardware. Sterilization of the indicator will not, in itself, prove that sterility of the lander capsule has been achieved; it will merely verify that the particular process being utilized was successfully applied. The process used to produce sterility must have been previously shown to be reliable and predictable as to the probability of attaining sterility. Author

N67-14775*# Massachusetts Inst. of Tech., Cambridge.
**SURVEY OF CERTAIN NONTHERMAL METHODS OF DECONTAMINATION AND STERILIZATION**
Gerald Silverman *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 193–206 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

The feasibility and limitations inherent in using ionizing radiations for spacecraft sterilization are discussed. The types of radiation for inactivating microorganisms are classified into particle radiations and electromagnetic radiations; for practical considerations, these are limited to fast electrons, X-rays, gamma rays, and ultraviolet light. The biological effects of ionizing irradiation are examined, and the radiation resistivities of several biological systems are given. Additional factors to be considered in this sterilization technique are identified as the dose rate, the presence of oxygen and organic materials, protective compounds, physiological state, water content, and temperature during irradiation. Microwave and dielectric heating processes and the use of lasers are considered briefly. M.G.J.

N67-14776*# National Aeronautics and Space Administration, Washington, D. C.
**DRY-HEAT STERILIZATION FOR PLANETARY-IMPACTING SPACECRAFT**
Carl W. Bruch *In its* Spacecraft Sterilization Technol. 1966 p 207–229 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

The dry-heat cycle of 135°C for 22 hours being investigated for the sterilization of planetary spacecraft is described herein. A historical approach of how that particular cycle was derived is presented. After an analysis of some of the environmental factors that influence dry-heat sterilization, various mathematical considerations of the available data are examined. By use of activation energy calculations, it is shown that some components might suffer less damage with high-temperature short-time cycles. It is also necessary to consider the integration of the lethality that occurs during the comeup time and cooldown time of the heating process with the lethality that occurs at the desired holding temperature. Author

N67-14777*# Army Biological Labs., Fort Detrick, Md.
**GASEOUS STERILIZATION**
Charles R. Phillips *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 231–257 refs Submitted for Publication (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

Ethylene oxide, formaldehyde, and beta-propiolactone are identified as the compounds used most frequently in gas sterilization applications, and the advantages and disadvantages of each are assessed. Based on a literature survey, other gases which are considered to have bactericidal properties are discussed. These include propylene oxide, ozone, methyl bromide gas, chloropicrin gas, epichlorohydrin and epibromohydrin, ethylene imine, glycidaldehyde, and peracetic acid. An extensive bibliography is included. M.G.J.

N67-14778*# Army Biological Labs., Fort Detrick, Md.
**FILTER APPLICATIONS FOR SPACECRAFT STERILIZATION PROGRAM**
Herbert M. Decker, Lee M. Buchanan et al *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 259–272 ref (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

Air filtration as a method of removing bacteria from the air is discussed in relation to the five categories of filters used in biological air cleaning. These are roughing filters; medium efficiency filters; high efficiency filters; ultrahigh efficiency filters, also classified as high efficiency particulate air filters; and filters for complete filtration. Test results of filters in each category are tabulated, and it is shown that the higher the efficiency, the greater the pressure drop across the filter. Also discussed is the development of a portable dioctyl phthalate test apparatus, for determining the effectiveness of installed filters in removing 0.3 micron particulate material from air. Methods of air cleaning by washing and scrubbing are reviewed, along with such techniques as the electrostatic precipitator, heat sterilization, and ultraviolet light treatment. M.G.J.

N67-14779*# Minnesota Univ., Minneapolis. School of Public Health
**SPACECRAFT CONTAMINATION RESULTING FROM HUMAN CONTACT**
Donald Vesley, Orlando R. Ruschmeyer, and Richard G. Bond *In* NASA, Washington Spacecraft Sterilization Technol. 05-05) GPO: HC $2.25; CFSTI: MF $2.50

Contamination transferred by workers in assembly processes is discussed, and summary data are presented on studies directed toward obtaining data about the extent of microbial contamination transferred by human hands. Tables are included to show the contamination detected on metallic and nonmetallic component materials after handling by groups of four persons; survival after storage of microorganisms on contaminated materials; and levels of microbial contamination detected during simulated component assembly trials under different control methods. Results of preliminary data analyses indicate: (1) Variability in microbial shedding from hands of different individuals is extremely high. (2) Nonmetallic substances such as epoxy laminates, Teflon, and Lucite may be more readily contaminated than metals and may retain viable particles for longer periods. (3) Sporeforming microbes comprise a very

high percentage of surviving species following 12 to 20 weeks of storage. (4) The use of sterile gloves or a single hand washing with a hexachlorophene soap can considerably reduce microbial transfer. M.G.J.

N67-14781*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**CONTAMINATION ANALYSIS AND MONITORING**
Jack D. Johnson et al *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 293–305 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

For an operational approach to certification of sterility of space hardware, it is necessary to apply the probability concept. The report is concerned with the applicability of mathematics to predict the probability of achieving sterility in a complex space hardware system. As such, this approach is concerned with the manipulation of microbiological data rather than mathematical rigor. Author

N67-14782*# National Aeronautics and Space Administration, Washington, D. C.
**SPACECRAFT STERILIZATION PROGRAM**
James R. Miles *In its* Spacecraft Sterilization Technol. 1966 p 309–311 (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.25

Some background information is provided on the implemantation and requirements of the sterilization program which is being conducted to create the technology needed to develop sterilizable spacecraft for planetary landings. R.N.A.

N67-14783*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**ELECTRONIC PARTS STERILIZATION PROGRAM AT THE JET PROPULSION LABORATORY**
Warren H. Lockyear *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 313–326 (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

This report documents the electronic parts sterilization program. The program is geared to reflect current NASA sterilization policy. The major effort of the current program is concerned with heat sterilization. The primary objective is to establish an approved list of heat sterilizable electronic parts. The secondary objective is to establish maximum information in the new era of higher operating temperatures and longevity of electronic parts. Author

N67-14877# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**EFFECT OF SPACE-FLIGHT FACTORS ON WHEAT SEEDS AND THE PLANTS PRODUCED FROM THEM**
G. V. Il'ina, N. N. Kuznetsova, S. G. Rydkiy, and V. G. Vysotskiy *In its* Cosmic Res. 4 Aug. 1966 p 241–247 refs (See N67-14881 05-30) CFSTI: HC $6.00/MF $1.50

The purpose of this investigation was to study the influence exerted by the factors of space flight on the sprouting and germination energy in wheat seeds, as well as the growth, development and harvest of plants produced from the seeds. We took Krasnozerne wheat seeds after they had been subjected to flights aboard the "Vostok-5" and "Vostok-6" space vehicles. Observations of the growth and development of the plants was carried out under the conditions of a vegetation experiment. Author

N67-14887*# Schwarz Bioresearch, Inc., Orangeburg, N. Y.
**SUPERIOR DIET FOR MAN IN SPACE Annual Report, Oct. 1965–Oct. 1966**
Norman A. Rosenthal Dec. 1966 288 p refs
(Contract NASw-517)
(NASA-CR-80969) CFSTI: HC $3.00/MF $2.60 CSCL 06S

Experiments were conducted to determine the stability of chemically defined liquid diets under several environmental conditions and to determine their effect on the intestinal flora of rats. Deterioration via the Maillard reaction was found to be a function of temperature and related to the presence of substances in the diet which can initiate free radical formation through peroxidation reactions. For long term storage with refrigeration, the amino acid and carbohydrate components of liquid diets should be stored separately and mixed just before feeding. A new mechanism of non-enzymatic browning (Maillard reaction) is proposed. This mechanism involves an induction period in which equimolar amounts of amino acid and aldose react to form an enolamine or ketosamine followed by free radical attack of the amine to cause oxidative polymerization. Differences exist in the intestianl floar of different rat strains and in rats of the same strain obtained from different sources. Under conditions where coprophegy is not prevented, the intestinal microflora of rats is not significantly modified by feeding chemically defined liquid diets. S.P.

N67-14891*# Hawaii Inst. of Geophysics, Honolulu. Geochemistry Div.
**SEARCH FOR BIOLOGICAL PROCURSOR MOLECULES IN VOLCANIC VOLATILE SYSTEMS Semiannual Status Report, Mar.–Dep. 1966**
John J. Naughton Sep. 1966 12 p
(Grant NGR-12-001-012)
(NASA-CR-80965) CFSTI: HC $3.00/MF $0.65 CSCL 07C

Studies of the natural volcanic gaseous system for its elemental and molecular composition and the equilibrium molecular and free radial components to be found in gaseous systems are presented. Activities included analysis of results following trends in the gas composition of a lava lake and fumarole. A high-dispersion spectrometer was constructed for measurement of emission and absorption spectra. Reflexing systems were set up over lava lake drill holes to simulate the thermal system that might evolve prebiotics in a volcanic or fumarole situation. Further work on the extraction and analysis of gases from inclusions in ultrabasic nodules from deep crustal sources is reported. S.P.

N67-14961# Library of Congress, Washington, D. C. Aerospace Technology Div.
**THE EFFECT OF SPACE FLIGHT FACTORS ON CENTRAL NERVOUS SYSTEM FUNCTIONS Surveys of Foreign Scientific and Technical Literature**
Christopher H. Dodge and Janice L. Smith 4 Aug. 1966 42 p refs Summary of Data
(ATD-66-99; TT-67-60029; AD-642186) CFSTI: HC $3.00/MF $0.65

The report summarizes 16 articles which concentrate heavily on the isolated and combined effects of acceleration and radiation on mammals. Titles are as follows: effect of radial accelerations on brain temperature; effect of centrifugation on otolith function; effect of vibration on cerebrospinal reflexes; effect of vertical vibration and noise on conditioned reflexes; changes in cerebral bioelectricity and oxygen metabolism; effect of vibration and analyzer exclusion on brain metabolism; cerebral oxygen metabolism, bioelectricity, and conditioned reflex activity during vibration; respiratory changes during vibration; X-ray effect on cerebral venous flow; comparative effect of neutron, proton, and gamma irradiation (300 rad); comparative effect of neutron and gamma irradiation (25 rad); comparative effect of neutron, proton, and gamma irradiation (150 rad); comparative effect of chronic and acute gamma irradiation and nervous activity; effect of prolonged gamma irradiation on vestibular function; combined effects of vibration and chronic irradiation on vestibular function; combined effects of vibration and ionizing radiation on conditioned reflexes. Author (TAB)

N67-14984# Siena Univ. (Italy). Inst. of Medical Pathology.
**BRAIN STEM SYSTEMS AND BEHAVIOR Final Scientific Report, 1 Jun. 1965–31 May 1966**
Cesare Bartorelli and Alberto Zanchetti Jul. 1966 62 p refs
(Grant AF-EOAR-65-6)
(AFOSR-66-2413; AD-640985) CFSTI: HC$3.00/MF$0.75

Research was performed: (1) on central and reflex regulation of emotional behavior; and (2) on central and reflex regulation of circulation during the wakefulness-sleep cycle. Author (TAB)

N67-14977# School of Aerospace Medicine, Brooks AFB, Tex.
**SPEED OF RECOVERY FROM CORIOLIS STIMULATION IN MOTION SICKNESS IN RELATION TO PILOTS AND NONPILOTS, JUNE–DECEMBER 1965**
Patrick J. Dowd Jul. 1966 11 p refs
(SAM-TR-66-63; AD-639598) CFSTI: HC$1.00/MF$0.50

Certain flight maneuvers, such as an aircraft banking and turning, can be simulated by the USAFSAM biaxial stimulator, resulting in a Coriolis effect. Motion sickness can easily be induced by Coriolis stimulation for both pilots and nonflyers. An ex post facto analysis of the rate of decay of vertical nystagmus was used to determine the differences between pilots and nonpilots who were sick or nonsick. Results implied that the more rapid the rate of decay of nystagmus, the more rapid the abatement of autonomic stimulation, which decreases the chances of summing activity over time to reach required levels for general visceral responses resulting in motion sickness. The findings demonstrate the effects of flying experience on the rate of decay of nystagmus elicited by a Coriolis stimulation. Author (TAB)

N67-15034# Ohio State Univ. Research Foundation, Columbus. Human Performance Center.
**THE EFFECT OF TEAM FEEDBACK ON INDIVIDUAL PERFORMANCE AND SELF-EVALUATION Final Report**
William A. Johnston and William C. Howell [1966] 15 p refs
(Grant AF-AFOSR-985-66)
(AFOSR-66-1948; AD-640404) CFSTI: HC$1.00/MF$0.50

The research program was designed to assess the role of team feedback in small-group activity. Team feedback was simulated by telling the subject that he had a partner and that feedback reflected his team performance relative to average performance. Actually, feedback represented the subject's individual tracking performance relative to a criterion, the stringency of which was manipulated experimentally. A stringent criterion produced poor feedback as though the subject had a poor partner, and a lenient criterion simulated a good partner. In general, the subjects performed best with good partners (lenient criteria). If one partner was replaced by a poorer partner, the subjects performance was retarded. The subjects accepted the credit for good team scores induced by a lenient criterion, but attributed the blame for poor scores wrought by a stringent criterion to their contrived partners. The data support the thesis that team feedback is an important determinant of individual behavior in the small group. Author (TAB)

N67-15042# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ON THE PROBLEM OF CHANGES IN PHYSICO-CHEMICAL AND BIOLOGICAL PROPERTIES OF PILOTS SALIVA DURING ROLLING, TURNING, AND HYPOXIA**
V. V. Yefimov, B. V. Tolokonnikov, and V. A. Gamburtsev 30 Mar. 1966 11 p Transl. into ENGLISH from Byull. Eksptl. Biol. i Med. (Moscow), v. 13, no. 5, 1942 p 44–47
(FTD-TT-65-1645; TT-66-62426; AD-640284) CFSTI: HC $1.00/MF$0.50

The change in composition of saliva during rolling, turning, and hypoxia is investigated. Specifically, the changes in physiochemical state of saliva by the surface of its tension on the boundaries with air and liquid (benzol). A comparison of the data on change in the surface tension and the degree of rolling showed that only surface tension values on the boundary with benzene gave a correlation with rolling degree. A comparison of surface tension changes in the saliva and urine demonstrated that urine also changes its surface tension at ascends, but these changes are less considerable and regular than in saliva. Experiments were also carried out to determine the surface tension of saliva among pilots during passage flights on civilian aircraft. It is concluded that surface tension of human saliva changes in a majority of cases regularly due to the action of rolling, rotation, and hypoxia. S.P.

N67-15069# Naval Medical Research Inst., Bethesda, Md.
**AN ABSORPTION SPECTROPHOTOMETER CELL FOR USE AT HIGH PRESSURES AND ITS APPLICATION TO AN ENZYMIC REACTION**
Robert F. Steiner 7 Nov. 1966 16 p refs
(Rept.-32; AD-641910) CFSTI: HC$1.00/MF$0.50

A cell designed for absorbancy measurements at high pressures has been constructed and used for a study of the pressure dependence of a thrombincatalyzed hydrolysis. Thrombin is not inactivated at pressures up to 20,000 psi. The rate of hydrolysis of a synthetic substrate (toluene sulfonyl arginine methyl ester) increases appreciably with pressure. Author (TAB)

N67-15076# Parma Univ. (Italy). Inst. of Human Physiology.
**PHYSIOLOGY OF CENTRAL VISUAL PATHWAYS Final Report, 1 Jan.–31 Dec. 1965**
A. Arduini 20 Jan. 1966 55 p refs
(Grant AF-EOAR-65-8)
(AFOSR-66-0176; AD-628081) CFSTI: HC$3.00/MF$0.50

The transfer functions of Lateral Geniculate Nucleus and of Visual Cortex I have been determined under conditions of steady state flickering illumination at fixed intensity. The results are compared with those of steady non-flickering stimulation. Microelectrode recordings under conditions of steady illumination with non-flickering light of different intensities have been made from individual fibers in the geniculo-cortical and in the corticothalamic tracts. An analysis of mean discharge frequency and of interspike interval distribution has been performed. Author (TAB)

N67-15089# RAND Corp., Santa Monica, Calif.
**A DIGITAL-COMPUTER MODEL OF SPIKE ELICITATION BY POSTSYNAPTIC POTENTIALS IN SINGLE NERVE CELLS**
R. J. MacGregor Sep. 1966 42 p refs
(Contract ARPA SD-79; ARPA Order 189-1)
(RM-4877-ARPA; AD-640268) CFSTI: HC$2.00/MF$0.50

A simulation of the information-processing function of nerve cells is presented. The computer model simulates the portion of the neuron at which spike potentials are initiated. Values for parameters were specified on the basis of neuroelectric recordings so that the results obtained might be pertinent to actual nerve cells. Trial runs verify that the model is accurately reproducing the functional forms of neuroelectric data. Input–output relations under regular input are given for a wide range of input frequency and pulse amplitude. Author (TAB)

N67-15118# Universidad Nacional Mayor de San Marcos de Lima (Peru). Instituto de Biologia Andina.
**HUMORAL CONTROL OF THE ERYTHROPOIESIS DURING ALTITUDE CHANGES Annual Report, May 1965–Apr. 1966**

Cesar Reynafarje, Jose Ramos, Jorge Gurmendi, Doris Villavicencio, and German Anduaga Apr. 1966 21 p refs
(Grant DA-ARO-49-092-65-G90)
(Rept.-1; AD-639752) CFSTI: HC $1.00/MF $0.50

A study was made of humoral control of erythropoietic activity in men during and after altitude exposure. Plasma from sea level subjects after 8, 24 and 48 hours of exposure to 4,450 meters of altitude produced a gradual increase of erythropoietic activity in starved rats. Urinary extracts had the same effect in samples obtained after 24 and 48 hours. No increase of erythropoietic activity was observed in plasma or urinary extracts from altitude natives when injected to rats. A depressing effect of plasma filtrate from altitude natives after 9 days of residence at sea level had a depressory effect on erythropoiesis in rats exposed to 18,000 feet. No changes of erythropoietic activity were observed when urinary extracts of natives of altitude were injected into starved rats after several periods of time at sea level. Additional observation in the urinary extracts from aplastic patients showed a very high degree of erythropoietic activity which diminished in patients successfully treated with anabolic steroid (meta-androstenolona). Author (TAB)

**N67-15121*#** National Aeronautics and Space Administration, Washington, D. C.
**THE ROLE OF THE VESTIBULAR ORGANS IN SPACE EXPLORATION**
1966 315 p refs 2d Symp. held Moffett Field, Calif. 25–27 Jan. 1966
(NASA-SP-115) GPO: HC $2.00; CFSTI: MF $3.35 CSCL 06S

Gravitoinertial receptor mechanisms and related systems are covered in papers presented at the second symposium on "The Role of Vestibular Organs in Space Exploration." For individual titles see N67-15122–N67-15147. M.W.R.

**N67-15122*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**RUSSIAN EXPERIENCE OF PROBLEMS IN VESTIBULAR PHYSIOLOGY RELATED TO THE SPACE ENVIRONMENT**
John Billingham *In its* The Role of the Vestibular Organs in Space Exploration 1966 p 5–13 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

Russian findings related to vestibular changes encountered during space and aircraft flights and simulated laboratory experiments are reviewed. Weightlessness and motion sickness are covered, particularly as related to man; and requirements for the selection and training of astronauts are reviewed. Animal studies deal with effects of prolonged periods of acceleration, including exposure to weightlessness in orbital flight and to accelerations of more than 1 g on the centrifuge. Short-term experiments aboard aircraft in parabolic flight are classified according to the following gross reactions: (1) general lack of response to stimuli; (2) development of specific illusions, such as oculogravic; and (3) immediate induction of motion sickness. It appears that the Russians have experienced a form of motion sickness in three of their cosmonauts, and it is noted that the changes in vestibular physiology display a wide variation among different individuals. M.W.R.

**N67-15123*#** Naval School of Aviation Medicine, Pensacola, Fla.
**THE INVERSION ILLUSION IN PARABOLIC FLIGHT. ITS PROBABLE DEPENDENCE ON OTOLITH FUNCTION**
Ashton Graybiel and Robert S. Kellogg (Aerospace Med. Div. Aerospace Med. Res. Labs. (6570th) *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 15–24 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

Observations were made on normal subjects and deaf persons with bilateral labyrinthine defects (L–D subjects) under three different conditions in parabolic flight: (1) free floating, (2) restrained in a fiberglass mold, and (3) "standing" on the overhead during a modified parabola generating about −0.05-g unit. There were interindividual differences in the reactions among the normal but not among the L–D subjects. Some of the normal but none of the L–D subjects experienced a reversal of their personal orientation with regard to up-down under all three conditions. This "reversal" was considered to have its genesis in the vestibular organs, probably the otolith apparatus. Our findings are in accord with Russian reports describing feelings of inversion among cosmonauts in orbital flight. Attention is called to the necessity of distinguishing between information furnished by touch pressure, kinesthesis, and stereognosis under ordinary conditions and agravic touch pressure, agravic kinesthesis, and agravic stereognosis. Author

**N67-15124*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**PROBLEMS OF MAN'S ADAPTATION TO THE LUNAR ENVIRONMENT**
William Letko, Amos A. Spady, Jr., and Donald E. Hewes *In its* The Role of the Vestibular Organs in Space Exploration 1966 p 25–32 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

Experimental observations indicate that with some training man should be able to maintain his equilibrium and orientation on the lunar surface. Effects of reduced gravity on the human body are reported; and relative motions of various body members while walking, loping, and sprinting are found to be quite different for the earth and lunar gravities. Not only are there large differences in amplitudes and rates of motion of these body members, but large differences in the body lean or back angle are seen as well as a large variation in back angle with rate of locomotion. These experiments indicate that man can maintain his equilibrium even while running at about 13 ft/sec; and results indicate that wearing a suit pressurized to 3.7 psi would not alter these general conclusions. Additional experiments in reduced-gravity simulators and in 1/6-g parabolic flight are considered necessary. M.W.R.

**N67-15125*#** Goteborg Univ. (Sweden).
**ANATOMICAL FEATURES OF THE AURICULAR SENSORY ORGANS**
Hans Engstroem, Henrik H. Lindeman, and Harlow W. Ades (Illinois Univ.) *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 33–48 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35
(Contract N62558-4264)

This paper contains a general survey of the structure of the vestibular sensory system—of the utricle, saccule, and semicircular ducts and crests. The major interest has been devoted to "gross" anatomical features, but a general description of the epithelial structure and also of nerve endings and blood vessels is included. Author

**N67-15126*#** Naval School of Aviation Medicine, Pensacola, Fla.
**DIMENSIONAL STUDY OF THE VESTIBULAR END ORGAN APPARATUS**
Makoto Igarashi *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 47–54 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

Micromeasurements were performed to determine the dimensions of the inner-ear apparatus in the human, the squirrel monkey, and the cat by using a series of horizontal sections. The membranous semicircular canal structure in the human is almost

twice as large as that of the squirrel monkey and of the cat, although the sizes of the skulls are quite different. On the other hand, the size of the canal crista is not significantly different among these three species. In other words, the human has a considerably smaller crista. The surface area of the human saccular macula is almost three times as large as that of the squirrel monkey and of the cat. Both the diameter of the cochlear base and the length of the basal membrane are less than twice as large in the human as in the other two species. Author

N67-15127*# Karolinska Institutet, Stockholm (Sweden).
**MORPHOLOGICAL POLARIZATION OF THE MECHANORECEPTORS OF THE VESTIBULAR AND ACOUSTIC SYSTEMS**
Jan Wersall and Per-G. Lundquist (King Gustaf V Res. Inst.) *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 57–72 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

The vestibular sensory cells in birds and mammals contain two types of sensory cells, whereas in frogs and fishes only one type is distinguished. All sensory cells in the labyrinth are morphologically polarized with regard to the centriole of the cell. One of the sensory hairs is identical in structure with a kinocilium protruding from the centriole. It is always found at the periphery of the sensory hair bundle. Available functional and morphological data from the acousticolateralis system indicate that maximum stimulation of the hair cell occurs when the sensory hairs are displaced toward the centriole and kinocilium of the cell. A kinocilium is found also on cochlear hair cells during development, but disappears from the cochlear hair cells of mammals during late stages of differentiation. The asymmetry of the sensory cell is considered to reflect an asymmetrical organization of the hair-bearing end of the sensory cells at the molecular level, forming a direction-sensitive transducer mechanism. It is suggested that the main orientation of the sensory cells, within a certain area of the sensory epithelium, reflects the directional sensitivity of that area, which allows a charting of each part of the inner ear with regard to its function. Author

N67-15128*# Birmingham Univ. (England).
**THE FUNCTIONAL SIGNIFICANCE OF THE ULTRASTRUCTURE OF THE VESTIBULAR END ORGANS**
Otto Lowenstein *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 73–90 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

The most important features of the comparative anatomy of the labyrinth are briefly reviewed. The cupula-endolymph system of the semicircular canals and the otolith organs are described as accelerometers sensitive to angular and linear acceleration. The signals generated by them in response to such stimuli are described with special reference to coding, and differential equations covering the transfer of information are introduced. The analysis of vestibular responses to supraoptimal stimulation in space-flight simulators is briefly mentioned. The ultrastructure of the sensory hair cell is then discussed in the light of our knowledge of its mode of functioning. The double innervation of the hair cell and the composition and topographic orientation of the sensory hair processes of the sensory cells in the cristae and maculae are described in this context. Finally, unsolved questions of mechanoelectric transduction are discussed. Author

N67-15129*# Defence Research Medical Labs., Toronto (Ontario).
**SPECIFIC GRAVITY AND VISCOSITY OF ENDOLYMPH AND PERILYMPH**
K. E. Money, M. Sokoloff, and R. S. Weaver *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 91–98 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35
(DRML-629)

Samples of endolymph and perilymph of between 0.002 and 0.003 milliliter were obtained from single ears of living pigeons. Measurements of specific gravity were made in density gradient column, and it was shown that at the pigeon's body temperature (approximately 40°C), the specific gravity (referred to water at 4°C) of endolymph is 1.0033 and that of perilymph is 1.0022. Preliminary measurements indicate that at 40°C, the viscosity of endolymph is 1.15 centipoise and the viscosity of perilymph is 0.78 centipoise. The unusual high potassium concentration and low sodium concentration of endolymph reported for the cat and the guinea pig were confirmed for the pigeon. Author

N67-15130*# Zurich Univ. (Switzerland).
**SOME MORPHOFUNCTIONAL AND PATHOLOGICAL ASPECTS OF THE VESTIBULAR SENSORY EPITHELIA**
H. Spoendlin *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 99–116 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

Neuronal connections in sensory epithelia and pathological aspects of the vestibular epithelia are discussed for 11 squirrel monkeys exposed to 5.4 g or 10.9 g on the centrifuge for periods up to 10 minutes in different head position. Although some of the monkeys manifested marked ataxia for hours following exposure, the ultrastructure of their maculae was not altered. A one-millionfold increase is considered necessary to produce damage in the cochlear receptor. Experiments in cats indicate that acute asphyxia caused no significant changes in vestibular sensory epithelia. Injection of a physiological sodium chloride solution into the endolymphatic space produced an interstitial base vestibular sensory edema. Animals that exhibited a mild vestibular reaction has somewhat irregular nuclei in a number of sensory cells; and electron microscopy confirmed the occurrence of pathological changes. Acute streptomycin intoxication produced marked pathological alterations in cristae; and, in cases where the streptomycin directly penetrated the labyrinth, most of the sensory cells were completely degenerated. Both type I and type II hair cells were affected. M.W.R.

N67-15131*# Oslo Univ., Blindern (Norway).
**ANATOMICAL ASPECTS ON FUNCTIONAL ORGANIZATION OF THE VESTIBULAR NUCLEI**
A. Brodal *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 119–141 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

The vestibular nuclear complex of the cat is detailed, and the various efferent and afferent connections of the vestibular nuclei are considered. Studies indicate that there are two main routes from the vestibular nuclei to the cord; one from the nucleus of Deiters forming the vestibulospinal tract, the other from the medial vestibular nucleus passing in the descending medial longitudinal fasciculus. In addition to the four classical nuclei (superior, lateral, medial, and inferior), the vestibular nuclear complex includes minor cell groups. Analyses of the efferent and afferent fiber connections of the vestibular nuclei support the suggestion that there is a functional difference between parts of nuclei and between cell groups. Study of the intrinsic organization of the vestibular nuclei and synaptic arrangements indicates the complexity of the nuclei, and that the cell groups or parts of nuclei are not functionally similar. M.W.R.

N67-15132*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**THE RELATIONSHIP BETWEEN THE UNIT ACTIVITY OF THE UTRICLES ACCULE OF THE FROG AND INFORMATION TRANSFER**
T. Gualtierotti and D. Alltucker *In its* The Role of the Vestibular Organs in Space Exploration 1966 p 143–149 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

The problem discussed is the coding system of the otolith organ in the inner ear. The spontaneous firing and the evoked responses of single otolith units show such a marked irregularity that the mechanism of information transmission cannot be based on instantaneous frequency modulation. Averaging of a single-unit discharge requires a long period of time to obtain enough accuracy, whereas the reflex mechanisms of balance act on a split-second basis. Evoked responses from single units bear a logarithmic relation to the stimulus both during transients and during steady states. Therefore, a theory of information based on "edges" is not completely satisfactory inasmuch as a graded response is not required. A new theory of information transmission is therefore presented, based on instantaneous averaging of the activity of a number of single otolith units through a time gate similar to that proposed for the auditory pathways. Author

**N67-15133*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**SPINAL REFLEXES DURING INCREASED GRAVITY**

Jorge Huertas, Francesco Bracchi, and Benjamin Epstein *In its* The Role of the Vestibular Organs in Space Exploration 1966 p 151–158 refs (See N67-15121 05-04) GPO: HC $2.00; MF $3.35

An experimental technique is described that permits repeated experiments on the same animal under the same conditions. Monosynaptic responses are obtained in both cats and monkeys by this chronic preparation method when 1 g was applied for periods of 2 to 5 minutes. In animals that are awake, the monosynaptic reflex shows a spontaneous variation in amplitude from one response to another; and at the onset of 1 g accelerational gravity and for several seconds thereafter, this variation disappears and the amplitude of the reflex increases. In all the animals there was a return to initial values after acceleration. Only after repeated accelerations, and particularly after higher values, was there a fall in reflex amplitude. It is found that the spinal reflexes are generally facilitated during acceleration, and it is postulated that a vestibular mechanism may influence this phenomenon. M.W.R.

**N67-15134*#** San Jose State Coll., Calif.

**INFLUENCE OF CONTACT CUES ON THE PERCEPTION OF THE OCULOGRAVIC ILLUSION**

Brant Clark and Ashton Graybiel (Naval School of Aviation Med.) *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 159–166 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

The influence of otolith and nonotolith information in the perception of the visual horizontal during rotation was studied. Five normal men and five men with defective labyrinthine function acted as observers. All measurements were made in a room which could be rotated. Initial, static measurements were made while the men stood erect in the stationary room. Similar measurements were made during rotation while the observer stood on a platform set to the resultant horizontal with head and body alined with the resultant force. Data were also obtained with three other combinations of head and body position. This pocedure was designed to produce two situations for the normal men in which otolith and nonotolith information were synergistic and three others in which they were antagonistic. The results showed that the perception of the visual horizontal during rotation in this situation is quite different from that found when the observer is rigidly supported in a chair during rotation. Author

**N67-15135*#** Army Edgewood Arsenal, Md.

**DOES LINEAR ACCELERATION MODIFY CUPULAR DEFLECTION**

George H. Crampton *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 169–184 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

Data from two experiments are described. In part I, human nystagmus was recorded with the head at the center of rotation and at a radius under a 1.06-g resultant. The magnitude of nystagmus, especially during constant velocity following angular acceleration, can be manipulated according to the orientation of the head with respect to the centripetal acceleration vector. In part II, single cells responsive to angular acceleration were recorded from anesthetized cat brain stem with the head at the center of rotation and at a radius under a 1.03-g resultant. Consistent differences in discharge rates were not found according to various orientations of the head with respect to the centripetal acceleration vector. It is concluded that these nystagmic changes are not due to direct acceleration effects upon the cupula, but are better explained in terms of a centrally converging otolithic influence. Author

**N67-15136*#** Naval School of Aviation Medicine, Pensacola, Fla.

**INFLUENCE OF LINEAR AND ANGULAR ACCELERATIONS ON NYSTAGMUS**

Fred E. Guedry, Jr. *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 185–198 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

Nystagmus and subjective responses were compared in experimental situations involving rotation at 10 to 30 rpm about an Earth-horizontal axis. At 10 rpm, responses were continuous throughout the period of rotation. At 30 rpm, responses showed a cyclic variation about a zero baseline after about 35 seconds. At this point, sensation of rotation was equivalent to that reported by labyrinthine-defective subjects in an earlier experiment. At both 10 and 30 rpm, cyclic variations in the slow component of nystagmus had a systematic phase relation to the cyclic variation in the direction of gravity. An experiment in which nystagmus was produced by horizontal linear acceleration revealed a consistency in results between the present experiment and several previous experiments. It is proposed that the prolonged nystagmus at 10 rpm and the cyclic variations in nystagmus (noted at all rotation rates) are an indication of separate mechanisms. Other experimental findings are discussed in relation to the proposed hypothesis. Author

**N67-15137*#** Royal Air Force, Farnborough (England). Inst. of Aviation Medicine.

**MODIFICATION OF PER- AND POST-ROTATIONAL RESPONSES BY THE CONCOMITANT LINEAR ACCELERATION**

A. J. Benson *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 199–213 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

The nystagmus and sensation of turning engendered by an angular acceleration are modified by the direction and magnitude of the concomitant linear acceleration. With a linear acceleration of 1 g, the rate of decay of postrotational responses was increased when otolithic and other gravireceptor signals were not in accord with signals from canal receptors. Responses to angular stimuli in yaw suffered a greater decrement than those in pitch or roll. From experiments in which the subject's orientation to gravity was changed immediately following an impulsive deceleration, it was concluded that these effects were brought about by inhibition, within the central nervous system, of canal afferents by competing gravireceptor signals. However, for higher linear accelerations and rotating linear acceleration vectors, it is not possible to exclude peripheral mechanisms. Author

**N67-15139*#** Franklin Inst., Philadelphia, Pa. Research Labs.

**DETERMINATION OF PHYSICAL CONSTANTS OF THE SEMICIRCULAR CANALS FROM MEASUREMENT OF SINGLE NEURAL UNIT ACTIVITY UNDER CONSTANT ANGULAR ACCELERATION**

Klaus L. Cappel *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 229–236 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

Labyrinthal responses to inertial stimulation are studied in relation to the mechanical properties of the semicircular canals, with the cupula-canal system considered as a damped spring-mass system with a single degree of freedom. It is noted, however, that its representation by a nonhomogeneous second-order differential equation has not always been correct. A decreasing response to continued stimulation is obtained from single nerve units in the anesthesized cat brain stem; and of 29 sets of data, nine have been analyzed. Damping-to-inertia and spring-constant-to-inertia ratios indicate there is underdamping during stimulation and overdamping during return, with the damping almost invariably higher in the return phase. This increase may be related to nonlinearities. Properties of the system are considered consistent with servo design practice in which an increase in gain would be balanced by an increase in damping to prevent instability. Further, a considerable proportion of the nerve units show remarkable symmetry of response under stimulation in opposite directions. M.W.R.

**N67-15140*#** Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.

**LACK OF RESPONSE TO THERMAL STIMULATION OF THE SEMICIRCULAR CANALS IN THE WEIGHTLESS PHASE OF PARABOLIC FLIGHT**

Robert S. Kellogg and Ashton Graybiel (Naval School of Aviation Med.) *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 237–243 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

The objective of this study was to clarify the mechanism of caloric nystagmus in man by conducting the test during weightlessness. Eight subjects were selected on the basis of a strong nystagmus response to irrigation with ice water. Nystagmus was determined by oscillograph tracings and direct observation, and, in addition, subjective responses of the subject were obtained. The experimental evidence indicated that, under the conditions of this experiment, zero gravity completely suppressed caloric nystagmus. This supported Barany's original hypothesis that caloric nystagmus was dependent on difference in specific weight of the endolymph in the horizontal canal. Author

**N67-15142*#** Illinois Univ., Urbana.

**NEEDS, PLANS, AND IDENTIFICATION OF THE PATHOLOGIC EFFECTS OF PROLONGED EXPOSURE TO WEIGHTLESSNESS ON THE VESTIBULAR ORGANS**

Harlow W. Ades and Hans Engstroem (Goeteborg Univ.) *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 257–262 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

Methods and possibilities of evaluating disintegration of structural components inside the vestibular system are presented. Many problems encountered are paralleled by those found in the evaluation of cochlear damage after exposure to noise or toxic agents. For that purpose special methods for analysis of the structural pattern and of the ultrastructure of the cochlear sensory epithelium were developed. It is recommended that a similar structural study be undertaken immediately on the vestibular epithelium. Substantial efforts must also be devoted to the problem of vascular supply in the vestibular labyrinth. Author

**N67-15143*#** Aerospace Medical Div. Aeromedical Research Lab (6571st), Holloman AFB, N. Mex.

**EXPERIENCE WITH THE CHIMPANZEE AS AN EXPERIMENTAL SPACE-FLIGHT ANIMAL**

Clyde H. Kratochvil *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 265–271 refs (See N67-15121 05-04) GPO: HC $2.00; MF $3.35

The experience of the laboratory with the two Project Mercury animal flights indicated that the chimpanzee was an excellent surrogate for man in this environment. Further experiments have been carried out using a complex multiple-operant schedule to evaluate the performance of the subject before, during, and after a rapid decompression to 150,000 feet. No permanent brain damage in any subject has resulted from a exposure of 150 seconds at this altitude. Another experiment was carried out to evaluate an advanced life support capsule. It was found here that major problems were the chronic restraint of the animal and the collection and disposal of urine and feces. Reliable solutions to these problems are needed before any prolonged animal flight can be considered. All experiments should require an evaluation of the ability of the subject to function in the new environment. The electroencephalogram, along with measures of psychomotor performance, has been found quite effective. Author

**N67-15144*#** Naval School of Aviation Medicine, Pensacola, Fla.

**LONG-TERM PERFORMANCE OF SQUIRREL MONKEYS UNDER SPACE SIMULATION CONDITIONS. PART I: CHARACTERISTICS OF APPROACH AND CAPSULE**

Deitrich E. Beischer *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 273–275 (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

The necessity and importance of orbital animal flights for a duration of 6 months is stressed. Such flights should closely simulate conditions in later manned space flight. Unrestrained animals, conditioned to perform certain tasks and observed by a television camera, are expected to furnish valuable physiological and behavioral information. A capsule housing life support and working stations for two squirrel monkeys was built and tested in laboratory experiments. A low-residue liquid diet promises great savings in food supply and waste disposal. Some results of long-term laboratory experiments are described. Author

**N67-15145*#** Naval School of Aviation Medicine, Pensacola, Fla.

**BEHAVIORAL TECHNIQUE, PART II**

John S. Thach, Jr. *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 276–282 (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

Behavioral measures were obtained from two squirrel monkeys under two-degree-of-space simulation conditions in order to evaluate the adequacy of the design. Relationships were established between work requirements and diet and water intake, weight, and efficiency of work. Extended and severe isolation appeared to reduce locomotor activity. When the monkeys lived under continuous light, their activity cycles increased to longer than 24-hour periods. The behavioral technique was sensitive yet stable, but limited by persisting problems with liquid diets. Author

**N67-15146*#** University of Southern Calif., Los Angeles.

**A PROGRAM FOR THE STUDY OF LONG-TERM ADAPTATION TO A WEIGHTLESS ENVIRONMENT PROVIDING THREE-DIMENSIONAL FREEDOM OF MOVEMENT**

J. P. Meehan and J. P. Henry *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 283–292 refs (See N67-14121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

The mechanical details of a working model of a proposed small-animal space station which is currently undergoing bench tests are briefly described, together with supporting evidence pointing to the feasibility of the program. The 12-cubic-foot canister weighs less than 300 pounds when loaded for a 9- to 15-month period. It would transmit data by slow-scan television, permitting determination of the growth and activity of a group of weightless mice. If feasible, animal recovery and/or substitution by rendezvous in orbit would supplement the data collected by television. Inclusion of a small preliminary test capsule in a manned Gemini or Apollo flight would permit determination of the effectiveness of the life support, waste disposal, and nesting arrangements before commitment to a full-scale long-term flight. Animals born and raised in such a station would have lacked throughout half a lifetime the normal otolithic and proprioceptive information differentiating subjective space into an up-and-down and sideways. Given recovery, measurement of the effect of such deprivation on their adaptation to horizontal and vertical mazes in a 1-g environment would be possible. Author

**N67-15147*#** University of Southern Calif., Los Angeles.
**CENTRAL NERVOUS, CARDIOVASCULAR, AND VISUOMOTOR STUDIES RELATING TO SPATIAL ORIENTATION IN A 30-DAY PRIMATE FLIGHT**
W. R. Adey *In* NASA, Washington The Role of the Vestibular Organs in Space Exploration 1966 p 293–307 refs (See N67-15121 05-04) GPO: HC$2.00; CFSTI: MF$3.35
(Contract NAS9-1970; Grants NaG-502; NsG-505; AF-AFOSR-246-63; AF-AFOSR-61-81)

Central nervous mechanisms underlying orienting and visual discriminative functions are discussed. Interrelations of vestibular and optic sensory influxes with corticodiencephalic and limbic mechanisms as essential substrates for spatial orientation are reviewed. Techniques for central nervous, cardiovascular, peripheral nervous, and autonomic monitoring during the 30-day primate flight in Biosatellite D are discussed. A 6.8-kilogram Macaca nemestrina monkey will be tested in two behavioral tasks involving delayed matching-to-sample, and an eye-hand coordination test. Environmental support involves an oxygen-nitrogen gas system. Pellet feeding combines reward and ad libitum methods, with water provided from the fuel cell power system. Data acquisition and analysis techniques are reviewed. Author

**N67-15152*#** General Technical Services, Inc., Yeadon, Pa.
**GENERAL DYNAMICS OF THE PHYSICAL-CHEMICAL SYSTEMS IN MAMMALS**
A. S. Iberall, M. H. Ehrenberg, and S. Z. Cardon Aug. 1966 110 p refs
(Contract NASw-1066)
(NASA-CR-81081; Rept.-6) CFSTI: HC $3.00/MF $1.30 CSCL 06P

Models of dynamic regulator chains to account for the dynamic characteristics of selected systems in mammals from a physical-chemical point of view are discussed. It is quite clear that a highly coordinated central thesis of dynamic regulation (homeokinesis) has emerged as the physical basis for the physiological view of homeostasis, both for physiological and psychological phenomena. Its foundation is a large class of oscillators, forming a rather extensive biological spectrum, whose dynamic shifting represents the paths toward regulation. Most characteristic of the biological system is the moment to moment locking of the oscillator systems into orbital synchronous paths, whose stability margins are determined by cues furnished by external and internal inputs to the brain. The nervous system images a patterned memory for guide algorithms upon which to act. Author

**N67-15162#** Joint Publications Research Service, Washington, D. C.
**THE USE OF ELECTRONICS IN PHYSIOLOGICAL RESEARCH**
Ye. Babskiy, I. Akulinichev, and O. Bokser 12 Jan. 1967 8 p Transl. into ENGLISH from Med. Gazeta (Moscow), 5 Dec. 1966 p 3
(JPRS-39499; TT-67-30149)

The cooperation of the sciences of medicine and electronics is particularly felt in the study of higher neural activity and neurophysiological investigations. Devices for these complex studies such as many-sided reflexometers, and equipment for the storage, processing, and evaluation of data are described with emphasis placed in the field of mathematical methods for evaluating neurophysiological information. A.G.O.

**N67-15169#** Joint Publications Research Service, Washington, D. C.
**ORGANOTIN COMPOUNDS USED IN CONTROL OF PLANKTON GROWTH**
N. S. Stroganov 28 Dec. 1966 7 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 170, no. 5, 1966 p 1189–1191
(JPRS-39292; TT-66-35714) CFSTI: $1.00

The algi- and zoocidal properties of organotin compounds were investigated to determine the feasibility of using these compounds for water purification in industrial enterprises. Results show that organotin inhibits the viability of algae and daphnia even at a concentration of 0.02 mg/liter. It is concluded that organotin compounds have an advantage over mineral tin because they prove toxic for planktonic organisms at substantially lower concentrations. A.G.O.

**N67-15179#** Joint Publications Research Service, Washington, D. C.
**RADIOTOXICOLOGICAL ASPECTS OF RADIOACTIVE CONTAMINATION**
Gh. Furnica and N. Racoveanu 29 Dec. 1966 15 p refs Transl. into ENGLISH from Igiena (Bucharest), v. 15, no. 10, 1966 p 577–587
(JPRS-39318; TT-66-35740) CFSTI: $1.00

Aspects of radiotoxicology are reviewed with emphasis placed on the importance of new studies such as calculation of the internal radiation dose, the path followed during incorporation, absorption, retention, and excretion of radionuclides, specific metabolism of radioactive isotopes, decontamination and forced excretion of nuclides, and the methods used for controlling contaminations. A.G.O.

**N67-15180#** Joint Publications Research Service, Washington, D. C.
**REVIEW OF NON-SOVIET RESEARCH WITH DOLPHINS**
29 Dec. 1966 5 p Transl. into ENGLISH from Sov. Kreanyy Krest (Moscow), no. 5, 1966 p 18–19
(JPRS-39317; TT-66-35739) CFSTI: $1.00

Experiments dealing with man's efforts to "understand the language of dolphins" are reviewed. Analysis of the sounds produced by dolphins has led to the identification, in addition to various kinds of whistles and shrill sounds, of such rarely occurring sounds as grunts and calls. It is reported that certain whistles were used as calls, while others were used for transmission of information. The whistling sounds, which consisted of rising and falling notes followed by low sounds, were found to represent conversational phrases. A.G.O.

N67-15261# School of Aerospace Medicine, Brooks AFB, Tex.
**EVALUATION OF AORTIC BLOOD VELOCITY COMPUTED FROM THE PRESSURE PULSE, SEPTEMBER 1963–APR. 1966**
John D. Boyett, Darwell E. Stowe, Leroy H. Becker, and William E. Britz, Jr. Aug. 1966 11 p refs
(SAM-TR-66-75; AD-639642) CFSTI: HC $1.00/MF $0.50

A method for computing aortic blood flow from the aortic pressure pulse by analog computer technics was evaluated. The method provides a continuous stroke-by-stroke indication of aortic blood flow through the use of a simple cardiac catheter. Aortic blood flow calculated from the area under the computed linear velocity curve was compared with cardiac output which was obtained by indicator dilution technics. Good correlation was found to exist between the two methods. Author (TAB)

N67-15264# Honeywell, Inc., Minneapolis, Minn.
**INFORMATION ANALYSIS OF THE ELECTROENCEPHALOGRAM Final Scientific Report, 1 Sep. 1965–31 Aug. 1966**
Donald I. Tepas Sep. 1966 31 p refs
(Contract AF 49(638)-1601)
(AFOSR-66-1941; Doc.-12021-FRI; AD-639712) CFSTI: HC $2.00/MF $0.50

Average potentials synchronized with cardiac cycle, motor activity, auditory stimulation, and visual stimulation were reliably detected and isolated in the electroencephalographic activity from one pair of scalp leads. The results indicate that the averaging technique need not be limited to the detection of potentials directly evoked by sensory stimulation. The data also demonstrate that it is possible to detect and measure several average potentials in a single human electroencephalographic recording. In addition, the data show that time-locked average potentials simultaneously present in a given electroencephalographic recording can summate in an algebraic manner. This suggests that a major portion of conventional electroencephalographic recordings may consist of the algebraic sum of a number of concomitant specific potential changes. The averaging technique is suggested as a general method whereby component parts of electroencephalographic activity can be separated for systematic experimental analysis. Author (TAB)

N67-15271# Aerospace Medical Div. Arctic Aeromedical Lab., Fort Wainwright, Alaska.
**OXYGEN CONSUMPTION AND BODY TEMPERATURES OF ESKIMOS DURING SLEEP Technical Report, 17 Jun.–3 Jul. 1963**
Frederick A. Milan and Eugene Evonuk 3 Jul. 1966 22 p refs
(AAL-TR-66-10; AD-639670) CFSTI: HC $1.00/MF $0.50

The paper reports the results of measurements of metabolism and body temperatures taken during 14 nights of comfortably warm sleep in six male Eskimos from the village of Wainwright on the arctic coast of Alaska. The mean age of these subjects was 20.8 (plus or minus 1.26) years, mean height 169.1 (plus or minus 5.08) cm, mean weight 66.6 (plus or minus 2.0) kg and mean value for percent body fat 9.1 (plus or minus 1.06)%. These data show the effects of the sleep cycle on metabolism and body temperature. The sleeping metabolic rate declined from 50 (plus or minus 7.35) kcal/sq m/hr at 2230 hours to 39 (plus or minus 5.22) kcal/sq m/hr at 0600 hours. Concomitantly, rectal temperature, which was negatively correlated with time ($r = -.965393$), fell from 37.0 (plus or minus .386) C at 2230 hours to 35.4 (plus or minus .386) C by 0600 hours. Calculated mean body temperature was directly related to the level of metabolic activity. These coastal Eskimos had essentially normal values for early morning basal metabolic rates in contrast to Anaktuvuk Pass Eskimos from the interior of Alaska who are hypermetabolic. Author (TAB)

N67-15272# Universidad Nacional Mayor de San Marcos, Lima (Peru).
**PATHOLOGY AT HIGH ALTITUDE Annual Report, May 1965–Apr. 1966**
Alberto Cuba-Caparo, Juan Takano, Leoncio Vega, and Ramon Puron Apr. 1966 15 p
(Contract DA-ARO-49-092-65-G91)
(Rept.-1; AD-639753) CFSTI: HC $1.00/MF $0.50

The study of 41 autopsies and 276 surgical and biopsy specimens from high altitude, 12,000 feet above sea level, are presented. The autopsy results are given in three tables, showing the distribution by age, race and sex of the patients; the fundamental diagnosis in four groups (prematures, new born, children and adults); and the anatomo pathological diagnosis. The pathological diagnosis of two hundred seventy six surgical and biopsy specimens are shown. They are classified as: (a) Tumors, (b) Inflammation, (c) Parasitic diseases and (d) Miscellaneous. These specimens, collected in eight and a half months of work in Chulec Hospital and Hospital Obrero de la Oroya, are insufficient to draw conclusions about the incidence of the different observed diseases. TAB

N67-15287*# Sandia Corp., Albuquerque, N. Mex. Planetary Quarantine Dept.
**PRODUCTION OF LOW CONCENTRATION PARTICULATE AEROSOLS BY A SONIC DISSEMINATOR TECHNIQUE**
Virgil L. Dugan Dec. 1966 17 p
(NASA Order R-09-019-040)
(NASA-CR-81147; SC-RR-67-14) CFSTI: HC $3.00/MF $0.65
CSCL 06B

Details are given on an ultrasonic vibrator technique which can produce particulate aerosols with concentrations levels below 5000 particles per cubic foot in an enclosed volume. Data are also included to show the repeatability with which a given concentration may be obtained on a surface for a given settling period. The basic operation of the sonic disseminator is described, along with the experiments which were conducted in a class 100 laminar flow clean room facility. Results indicate that the disseminator is suitable for either viable or nonviable particulate aerosols, and is capable of aerosolizing the contaminant particles in their individual states. M.G.J.

N67-15329# Brussels Univ. (Belgium).
**RESEARCH CONCERNING THE INFLUENCE OF ACUTE EXPOSURE TO COLD ON THE THYROID FUNCTION Final Report, 1 Sep. 1963–31 Aug. 1966**
A. M. Ermans and M. Camus Ft. Wainwright, Alaska, Arctic Aeromed. Lab., Jul. 1966 38 p refs
(Contract AF 61(052)-714)
(AAL-TR-66-7; AD-639669) CFSTI: HC $2.00/MF $0.50

The quantitative aspects of iodine metabolism were evaluated in normal healthy human subjects by means of a tracing method and long-term iodine balance studies. The behavior of the specific activities of hormonal iodine in the intra- and extra-thyroidal compartments cannot be explained on the basis of a relationship of precursor to product when the thyroidal compartments are considered as a whole. On the contrary, experimental findings fit with such a relationship if one considers the fraction of the thyroid compartment which is mobilized by exogenous TSH. A kinetic model of iodine metabolism taking account of such a functional heterogeneity was studied by means of digital and analog computers. One interesting aspect of this heterogeneity is the very high specific activity of the organic iodine released by TSH, when TSH is given a short time after the administration of radioiodine. This approach appears to be a very sensitive method for the detection of any TSH-like effect on the thyroid gland. This property has been used for the estimation of the influence of an acute exposure to cold on the thyroid function of eight volunteers. Twenty-four

hours after the administration of I-125 the volunteers were kept for two hours at 4°C. A marked increase of the levels of PBI-125 was observed four hours after the end of cold exposure; plasma PBI-127 was also increased but to a lesser extent; the validity of these findings was checked by a parallel experiment at normal temperature. Author (TAB)

N67-16334# Florida State Univ., Tallahassee. Dept. of Statistics.
**THE USE OF LIMIT THEOREMS IN PAIRED COMPARISON MODEL BUILDING**
W. A. Thompson, Jr. and Jagbir Singh Jun. 1966 21 p refs
(Contract Nonr-988(08); Grant NSF GP-3807)
(M111; ONR-TR-20; AD-639656) CFSTI: HC $1.00/MF $0.50

The Thurstone and the Bradley-Terry models, both initially advanced on intuitive grounds, have proved useful in the analysis of paired comparisons. The psychological meaning of these models and their relation to one another is unclear, but they fit data. Stevens has observed that there may be two basic mechanisms of discrimination (1) additive and (2) substitutive. We advance two corresponding mathematical models: that experienced sensation is (1) the sum of a large number of independent signals and (2) the maximum of a large number of independent signals. These assumptions yield (1) Thurstone's model and (2) the model of Bradley-Terry. Psychological interpretations of the various parameters, in terms of sensation, present themselves in a natural manner. Thus this paper presents a theory which unifies and interprets two paired comparison models that have proved useful in fitting experimental data. Author (TAB)

# 05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N67-14719# Air Force Systems Command, Brooks AFB, Tex.
**AEROSPACE MEDICINE CONSIDERATIONS IN MANRATING SPACE ENVIRONMENT SIMULATORS**
Paul W. Musgrave and Donald I. Carter Jun. 1966 26 p refs
(AMD-TR-66-2; AD-639645) CFSTI: HC $1.00/MF $0.50

Manrating of space environment simulators has become a necessity to facilitate the operation of these devices and to carry out testing of equipment within near-vacuum conditions. Protection of the individual performing duty within these environment extremes has presented interesting problems to the physician, physiologist, and engineer. This paper describes the physical facility requirements and operational procedures which must be integrated to provide a satisfactory degree of safety for these personnel. Author (TAB)

N67-14761*# National Aeronautics and Space Administration, Washington, D. C.
**SPACECRAFT STERILIZATION TECHNOLOGY**
1966 601 p refs Conf. held at Pasadena, Calif., 16–18 Nov. 1965; Sponsored by NASA
(NASA-SP-108) GPO: HC $2.25; CFSTI: MF $2.50 CSCL 06T

Conference papers on NASA sterilization requirements, microbiological control and monitoring, and sterilization techniques are presented. For individual titles see N67-14762–N67-14797. Author

N67-14762*# Illinois Univ., Urbana.
**BASIS FOR THE STERILITY REQUIREMENT**
Kimball C. Atwood *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 3–10 (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

The necessity for spacecraft sterilization is assessed from two viewpoints: the scientific gains that may not be realized if some significant effect of contamination of the extraterrestrial sites should occur; and the probability that any significant effect will occur. The Martian environment is discussed in relation to the multiplication of terrestrial organisms, and the question of what would happen if earth contaminants were picked up in an assay of Martian matter is examined. Life detection instruments, and their limitations, are considered, and it is suggested that an attempt be made to obtain evidence that no organisms like terrestrial organisms are present. Another stratagem proposed is the extensive use of life detection instruments that are not especially designed to detect extraterrestrial biota but will detect terrestrial-like organisms in an extraterrestrial environment. M.G.J.

N67-14780*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**ENGINEERING PROBLEMS IN STERILIZATION OF SPACECRAFT**
Victor J. Magistrale *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 285–292 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

The kinds of engineering problems engendered by the spacecraft sterilization requirement are surveyed in relation to its effect on all aspects of design, hardware development, assembly, test, and launch of a spacecraft and capsule. Two mission modes for planetary exploration are considered: an impact trajectory with deflection of the spacecraft; and a flyby trajectory of the spacecraft with subsequent capsule deflection. Subsystems hardware problems and operational problems incurred by the sterilization criteria are also assessed, and various approaches proposed as solutions to these problems are discussed. Among the points made in the survey are: (1) Recognition of the probabilistic approach is mandatory as it provides an analytical basis for sound engineering judgment. (2) A quantitative methodology, in the form of a mathematical method of counting microorganisms, should be developed to determine how microbial contamination varies with the imposition of sterilization requirements. M.G.J.

N67-14876# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**MEDICAL MONITORING OF THE CONDITION OF COSMONAUTS BELYAYEV AND LEONOV DURING TRAINING AND ORBITAL FLIGHT**
I. T. Akulinichev, A. S. Antoshchenko, V. A. Znachko, A. Ye. Ivanov, V. I. Lebedev et al *In its* Cosmic Res. 4 Aug. 1966 p 224–240 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

Results are presented on the medical monitoring of the condition of cosmonauts Belyayev and Leonov during high-altitude training sessions in a pressure chamber, in carrying out portions of their flight assignment in a training vehicle and during Leonov's extravehicular activities outside the "Voskhod-2" vehicle in outer space. Medical monitoring data analysis demonstrated that under conditions of ground training, as well as during orbital flight, both cosmonauts exhibited temporary functional disruptions of physiological functions, associated with nervous-emotional stresses, and in Leonov's case with application of considerable physical stresses. Author

N67-14889*# Hamilton Standard Div., United Aircraft Corp., Broad Brook, Conn.
**MEDICAL AND BIOLOGICAL APPLICATIONS OF SPACE TELEMETRY Final Report**

[1966] 109 p refs
(Contract NASw-846)
(NASA-CR-80967) CFSTI: HC$3.00/MF$1.30 CSCL 06B

A lengthy definition of biotelemetry is presented, and medical and biological applications are enumerated. By means of telemetry in intensive care wards, the status of the acutely ill patient can be constantly monitored and assessed. Continuous monitoring and warning signals provided by biotelemetry can inform the surgeon and anesthesiologist of the patient's condition during operations. The use of biotelemetry for diagnostic monitoring of the heart's activities during minor operations in the hospital or in the doctor's office is discussed. Information is presented on telestimulator systems used in conjunction with telemetry devices, so that physiological responses of subjects receiving electric stimulation of the brain can be remotely observed. System characteristics, psychophysiological applications, space applications, and possible medical uses for such systems are described. Finally the microminiaturization of biotelemetry systems for reduced size, lower power, and increased reliability is considered. S.P.

N67-14966# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**MAN IN A SPACESHIP**
A. Lebedinskiy, S. Levinskiy, and Yu. Nefedov 6 Apr. 1966 14 p Transl. into ENGLISH from Med. Gazeta (USSR), 18 Sep. 1964 p 3
(FTD-TT-65-1591; TT-64-51542; AD-640255) CFSTI: HC $1.00/MF$0.50

Prolonged tests on human subjects in hermetically sealed chambers showed that the atmospheric composition in the enclosure is the most essential factor that influences the organism of the human subject under observation. Individual differences in metabolisms of different men reflect on the qualitative and quantitative composition of volatile contaminants exuding into the air as well as the microflora compatibility. Supplementary cleaning of the air from bacteria and chemical admixtures, ultraviolet radiation of the skin, introduction of increased quantities of vitamins in the food ration, special complex physical exercises and some medical media, as well as the organization of a gradual transition from test conditions to normalcy are recommended to overcome medical and psychological factors of space travel. G.G.

N67-14996# FMC Corp., Santa Clara, Calif.
**ON SITE SIMULATION OF SOURCE DATA GENERATION Technical Report, 14 Jun. 1965–1 Jul. 1966**
Bruce N. McArthur, Anne Melby, and George Reid Wright-Patterson AFB, Ohio, Res. and Tech. Branch, Aug. 1966 181 p refs
(Contract AF 33(615)-3156)
(ASD-TR-66-12; AD-639755) CFSTI: HC$5.00/MF$1.00

An onsite study of source data generation by operational personnel in a simulated operational environment was performed. The purposes were to measure source data error levels, determine the effects of performance feedback, goal-setting, special type font and special handprinting instructions, on source data accuracy, and develop effective criteria for personnel selection and assignment. Criteria tested for potential in personnel selection and assignment included standard and specially designed clerical aptitude tests, general intelligence tests, a nonprojective personality test, a vocational interest blank, Civil Service supervisory tests, visual acuity scores, and other human factors. A representative sample of personnel involved in source data generation on-the-job was comprised of 15 women and 33 men. Operational simulation experiments employed typical source data materials. For a reading and legibility study, computer-generated synthetic codes were used. Author (TAB)

N67-15024# Naval Submarine Medical Center, Groton, Conn.
**FREQUENCY SHIFTS OF A WHISTLE BLOWN IN DIFFERENT GASES**
Russell L. Sergeant 29 Sep. 1966 7 p
(MR-66-16; AD-640378) CFSTI: HC$1.00/MF$0.50

In a study of the resonating characteristics of a whistle in an effort to explain variations in voice quality observed in helium speech, it was found that the pure tone production of a whistle follows the same principles for frequency resonance as that found in the human voice. Different degrees of upward shift in frequency occur for pure oxygen or a helium mixture. A taped signal does not change when played in helium-rich environment. Diffusion rates between gases appears to be important for minor shifts when the gas breathed is not the same as the environmental gas spoken into. Information presented in this report helps explain why helium speech, which is an important aspect of diving and underwater communications, sounds unusual. Author (TAB)

N67-15064# Delaware Univ., Newark. Center for Research on Social Behavior.
**COMPONENTS OF GROUP RISK TAKING**
Allan I. Teger and Dean G. Pruitt (State Univ. of New York at Buffalo) 26 Aug. 1966 38 p refs
(Contract Nonr-2285(02))
(TR-18; AD-640018) CFSTI: HC$2.00/MF$0.50

In a partial replication of an earlier study by Wallach and Kogan, group risk taking was examined under conditions of discussion and information exchange. Group size was also manipulated. Unlike the earlier findings, a risky shift occurred in the information exchange condition, where the subjects only revealed to one another the contents of their prior decisions. A stronger risky shift was found when discussion was permitted. Risky shift was more pronounced the larger the size of the group. The extent of risky shift on a decision problem was found to be positively related to the initial level of risk on that problem. The results appear to support Brown's value of risk theory of group risk taking more closely than any other theory. Author (TAB)

N67-15073# Istituto Nazionale di Ottica, Florence (Italy).
**SUBJECTIVE SHARPNESS THRESHOLD IN MAXWELLIAN VIEW AND UNDER NORMAL VIEWING CONDITIONS**
Marcella Bittini and Renato Sulli (Pisa Univ.) [1965] 11 p refs Repr. from Atti Fond. Giorgio Ronchi Contrib. Inst. Nazl. Ottica (Arcetri-Florence), anno. 20, no. 3, May–Jun. 1965 p 297–308 *Its* Pubbl. Dell'Ist Nazl. di Ottica, Ser. II, No. 1113
(Contract AF 61(052)-850)
(AD-637096)

Subjective sharpness threshold, relative to a given test object, is determined and related to absolute threshold. The case of Maxwellian view is compared to normal viewing conditions. The two types of vision are found not to be interchangeable, and the difference is found to vary as a function of the size of entrance pupil of the eye. The findings are discussed in terms of the effects produced by diffraction phenomena and the eye aberration on the light distribution in the retinal image. Author (TAB)

N67-15097# HRB-Singer, Inc., State College, Pa.
**THE PSYCHOLOGICAL ENVIRONMENT OF PROTECTIVE SHELTERS Final Report**
Grace H. Wright and Nancy H. Fenstermacher Jul. 1966 146 p refs
(Contract OCD-PS-65-5)
(Rept.-75111-2F; AD-642296) CFSTI: HC$3.00/MF$0.65

The study was designed to cross-validate measuring instruments, to provide a refinement of methodology for use in future

shelter studies, to investigate the effects of specified shelter relevant stresses, and to approximate a standard for evaluation of indices of psycho-social stresses occurring in shelter confinement. These purposes were accomplished by comparing the reactions of two equivalent groups, one subjected to selected stresses and the other not, on specifically designed rating forms, tests, and experimental tasks. All other conditions of confinement were equivalent for the two groups. The validation procedure consisted of comparisons between the original group from the psychiatric hospitals and both groups from the shelter confinements. Additional information was obtained through the use of two groups in the validation portion of the study. The results of the study indicated that a shelter group who received supplementary psychological supports evidenced a greater acceptance of confinement than the group for whom none were provided. The experimental data validated previous findings and showed that certain behaviors appear to be important in the psychological environments that exist at the beginning of and following a period of confinement. Author

**N67-15119#** Federal Aviation Agency, Oklahoma City, Okla.
**A HOMOGENEOUS FIELD FOR LIGHT ADAPTATION**
Henry W. Mertens Sep. 1966 5 p *ref*
(AM-66-38)

Visual judgments of size, distance, slant, etc. in the flying situation are often made under reduced cue conditions, especially during night flying. In the experimental study of spatial perception under these conditions, experiments often require long sessions in the dark and involve stimuli of low luminance allowing considerable dark adaptation to occur. The resulting change in visual sensitivity makes the control of light more difficult and increases the possibility that extraneous cues may contaminate the data. Light adaptation devices are often used to control this sensitivity but themselves may introduce extraneous cues, e.g., size and distance cues. This report describes a light adaptation device which produces a homogeneous adaptation field without extraneous cues and which can be used easily between experimental observations even though *S* is in an otherwise dark observation position. Author

**N67-15120#** Federal Aviation Agency, Oklahoma City, Okla.
**PILOT VISION CONSIDERATIONS: THE EFFECT OF AGE ON BINOCULAR FUSION TIME**
Carlton E. Melton, Jr. and Marlene Wicks Oct. 1966 9 p refs
(AM-66-35)

This study provides data regarding the relationship between vision performance and age of the individual. It has direct application to pilot visual tasks with respect to instrument panel displays, and to controller visual tasks in association with radar equipment. It also relates to the visual parameter important to the determination of a physiologic age rating for pilots. Author

**N67-15138*#** Massachusetts Inst. of Tech., Cambridge.
**CONTROL ENGINEERING APPROACHES TO HUMAN DYNAMIC SPACE ORIENTATION**
Laurence R. Young, Jacob L. Meiry, and Yao T. Li *In* NASA, Washington The role of the Vestibular Organs in Space Exploration 1966 p 217–227 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35
(Grant NsG-577)

Mathematical descriptions are given of the input-output relations characterizing the vestibular mechanisms; studies in eye stabilization, including the influence of vestibular inputs, neck proprioceptive inputs, and fixed-head visual tracking, are covered; and vestibular research is related to man as a member of a closed-loop system for controlling the orientation and position of a vehicle. Space orientation of the pilot is functionally divided into the study of sensors, the central system for control and compensation, and motor mechanisms by which the human transfers information back to the vehicle. The areas considered most important are visual, tactile, and vestibular inputs; and the usual joystick hand control and postural control are as outputs. Adaptive mechanisms for output control are studied to provide a mathematical description of the human operator as an input-output device or a set of devices. M.W.R.

**N67-15141*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**EXAMINATION OF A POSSIBLE FLIGHT EXPERIMENT TO EVALUATE AN ONBOARD CENTRIFUGE AS A THERAPEUTIC DEVICE**
Ralph W. Stone, Jr., William Letko, and W. Ray Hook *In its* The Role of the Vestibular Organs in Space Exploration 1966 p 245–256 refs (See N67-15121 05-04) GPO: HC $2.00; CFSTI: MF $3.35

General engineering and other factors involved in a flight experiment with an onboard centrifuge are investigated to substantiate or refute results of ground-based studies that have shown the onboard centrifuge capable of attenuating some of the expected effects of weightlessness. The onboard centrifuge could also permit the examination of the vestibular system in flight, the sensitivity and thresholds of the otoliths, and responses to stimulation of the semicircular canals. Since the centrifuge provides a means of simulating space flight maneuvers, its use in reentry simulation is suggested. Some physiological effects of weightlessness are reported, along with details of the ground-based centrifuge tests. Engineering considerations of an onboard centrifuge are detailed, as is the experimental program to evaluate the prophylactic and therapeutic value of exposure to centrifugal force as a means of preventing debilitation from weightlessness for extended missions. M.W.R.

**N67-15178#** Joint Publications Research Service, Washington, D. C.
**PROTECTIVE MASKS AVAILABLE FOR AGRICULTURAL WORKERS IN USSR DESCRIBED**
G. Kobrits 28 Dec. 1966 6 p Transl. into ENGLISH from Zashchita Rast. ot Vreditelei i Bolezney (Moscow), no. 9, 1966 p 30–32
(JPRS-39281; TT-66-35703) CFSTI: $1.00

Descriptions and operating characteristics are given for protective masks to prevent the inhalation of chemicals used in combating weeds, pests, and plant diseases. C.T.C.

**N67-15263#** Northwestern Univ., Evanston, Ill. Auditory Research Lab.
**AN EXPANDED TEST FOR SPEECH DISCRIMINATION UTILIZING CNC MONOSYLLABIC WORDS Auditory Test No. 6, 16 Jan. 1964–15 Apr. 1965**
Tom W. Tillman and Raymond Carhart Brooks AFB, Texas, School of Aerospace Med., Jun. 1966 16 p refs
(Contract AF 41(609)-2643)
(SAM-TR-66-55; AD-639636) CFSTI: HC $1.00/MF $0.50

Northwestern University Auditory Test No. 6 is composed of four lists of 50 consonant-nucleus-consonant (CNC) monosyllabic words each. The construction of the test followed the same scheme employed earlier in the development of N. U. Test No. 4, a less extensive version using the same type of material. The four lists of N.U. Test No. 6 were given twice to each of two subject groups--one group with normal hearing and another with sensorineural hypoacousis. During each administration, six ascending presentation levels were used ranging from -4 dB to 40 dB sensation level. The two groups yielded articulation functions highly

similar to those obtained with the earlier test (N.U. Test No. 4). The new test (N.U. Test No. 6) appears to have good interlist equivalence and high test-retest reliability. It thus retains the desirable features of the earlier tool while doubling the inventory of items available for the measurement of phonemic discrimination.
Author (TAB)

N67-15322# Stanford Univ., Calif. Systems Theory Lab.
**SEQUENTIAL DECISION AND CONTROL PROBLEMS IN SNAKE FORMS**
Tom G. Sharpe Jun. 1966 82 p refs
(Contract Nonr-225(83))
(SEL-66-049; AD-639705) CFSTI: HC $3.00/MF $0.75

The report is a study of properties and problems in multilink chains, or snake forms, biological snakes are not considered. The study deals primarily with geometric and kinematic details of movements of snake forms. The problem of general concern is that of placing the head of the snake on a given target. Subproblems arise as various schemes of target acquisition are discussed. Topics considered include minimax (in maximum curvature sense) snakes, sequential control, black box snakes (determining state from error measurements), path constrained target approach, minimum time target approach, binary (two position angle) snakes and adaptive target approach. It is found that the minimax convex snake with equal link lengths has the appearance of a piecewise linear approximation to an arc of a circle plus a straight line segment. Also, a sequential control scheme is developed that will carry the head to the target with a finite number of angle changes.
Author (TAB)

# 06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N67-14481# Marks Polarized Corp., Whitestone, N. Y.
**DEVELOPMENT OF AN INORGANIC PHOTOTROPIC SYSTEM FOR FLASHBLINDNESS PROTECTION Final Report, 28 Jun. 1963–27 Jun. 1964**
Alvin M. Marks Natick, Mass., Army Natick Labs., Jul. 1966 46 p refs
(Contract DA-19-129-AMC-158(N))
(TR-67-2-CM; C&OM-22; AD-639701) CFSTI: HC $2.00/MF $0.50

The report presents the details of a study made to determine the feasibility of using films containing one or more heteropoly acids for possible protection against flashblindness. Phosphomolybdic, phosphovanadomolybdic, phosphotungstic, silicotungstic, and silicomolybdic acids were evaluated. Methods for the preparation and purification of heteropoly acids in general are given. Also given are details for the preparation and purification of specific compounds: potassium-arseno-12-molybdate, phospho-18-molybdic acid, arseno-12-molybdic acid, purpureophospho-12-vanadic acid, and borotungstic acid. Films for evaluating the photochromic response were prepared by centrifugally spinning a thin film of acid-resin solution on a polyester substrate and evaporating the solvent. Photochromic response and capabilities were determined by (1) exposing the films to a xenon flash, an ultraviolet lamp, and a xenon-mercury arc; and (2) measuring the optical transmission or density before and after exposure. The response of several films, particularly phosphomolybdic acid in polyvinyl acetate (which changed from an optical density of 0.07 to a density of 3.4), indicates that further research in this area is warranted. Also, since several of the films were somewhat heat sensitive, a study of different resins in indicated. Author (TAB)

N67-14518*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**RHEOLOGY OF CONCENTRATED SUSPENSIONS: EFFECT OF A SURFACTANT**
R. F. Landel, B. G. Moser and A. J. Bauman *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 883–892 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00
(Contract NAS7-100)

A parallel plate plastometer was used to measure the apparent viscosities of slurries of ammonium perchlorate, glass beads, aluminum powder, and copper powder, in a straight-chain hydrocarbon mixture and in a more polar liquid, polyoxypropylene glycol. Asolectin, a mixture of natural phospholipids, was used as the wetting agent, at the optimum concentration for each slurry, i.e., at the concentration which produced the greatest decrease in viscosity. This optimum concentration was studied with the aid of surface area determinations and adsorption isotherms on the various powders and was found to correspond to one monolayer of surfactant, at least in the case of the glass beads. Maximum volumetric loadings $\phi_m$ were determined by centrifugation. Slurry concentrations were varied from 0.35–0.8 volume fraction of solids $\phi$, corresponding to a range of $\phi/\phi_m$ of 0.45–0.93. The apparent relative viscosity appears to be a unique function of this relative volumetric loading and independent of other factors, such as polarity of medium, type of particle, surface condition, and surface area. Over the concentration range studied, the response can be described by $\eta/\eta_0 = (1-\phi/\phi_m)^{-2.5}$ Author

N67-14613# Iowa State Univ. of Science and Technology, Ames. Ames Lab.
**RESEARCH REPORT IN CHEMISTRY**
F. H. Spedding, R. S. Hansen, C. V. Banks, T. A. Beineke, J. D. Corbett et al *In its* Chem., Eng., Met., Phys. and Reactor Div. Jul. 1966 111 p refs (See N67-14612 05-34) CFSTI: HC $7.94/MF $2.25

Various activities in the field of physical and inorganic chemistry are reported. Specific topics treated are: reactions and properties in low oxidation states, kinetics and mechanisms of inorganic reactions, reaction of iodine in iodochromium ion, kinetics of mercury catalyzed aquation of chloropentammine-chromium ion, aquation and formation of hypophosphitochromium ion, reactions of cyanide complexes, stopped-flow studies of very rapid reaction-aquation of azidoiron, high temperature chemistry, thermodynamic and magnetic properties of solids, surface chemistry, chemistry of heavy transition metals, separation of rare earths by ion exchange, properties of aqueous solutions of rare-earth electrolytes, and chemical mass spectroscopy. S.P.

N67-14614# Iowa State Univ. of Science and Technology, Ames. Ames Lab.
**RESEARCH REPORT IN ENGINEERING**
F. H. Spedding, G. Burnet, L. E. Burkhart, R. W. Fisher, F. O. Shuck et al *In its* Chem., Eng., Met., Phys. and Reactor Div. Jul. 1966 34 p refs (See N67-14612 05-34) CFSTI: HC $7.94/MF $2.25

A series of research reports are presented for the areas of chemical and ceramic engineering. Among the chemical engineering topics considered are: equilibrium data for a trivalent rare earth system, metal separation and purification by halo-genation processing, growth of oriented single crystals, and wetting characteristics of liquid metals. With respect to ceramic engineering such subjects as: sintering kinetics; atom movement, elasticity, and internal friction; resonant frequency determination; crystal growth; arsenic–selenium–sulfur glasses; molybdenum–liquid metal compatibility; and effect of pump duct width on electromagnetic pumping performance. S.P.

N67-14626*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**PHYSICAL ELECTRONICS AND SURFACE PHYSICS**
D. S. Shupe and R. E. Stickney *In its* Res. Lab. of Electron. 15 Oct. 1966 p 31–34 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25
(Contract DA-36-039-AMC-03200(E))

Presented is a study of the role of iron as a catalyst in the synthesis of ammonia by using high vacuum techniques and a mass spectrometer. The equilibrium data for the reaction are briefly discussed and the experimental apparatus is described. Ammonia was produced at easily measurable pressures by surrounding the iron catalyst inside and outside with hydrogen and nitrogen at $10^{-4}$ Torr, then pulsing the membrane while a "cold finger" center tube was being filled with liquid nitrogen. On warming the finger, ammonia desorbed from its surface and was thereafter present in the system in varying amounts until the next bakeout. K.W.

N67-14638# National Lead Co. of Ohio, Cincinnati. Feed Materials Production Center.
**[FEED MATERIALS] Summary Technical Report, 1 Apr.–30 Jun. 1964**
R. Burgett, ed. 19 Aug. 1964 70 p refs
(Contract AT(30-1)-1156)
(NLCO-920) CFSTI: $1.75

Articles are presented concerning the following work: (1) use of cathodoluminescence in conjunction with microprobe techniques to identify phases containing light elements; (2) microprobe analysis of the various phases of uranium metal recovered from magnesium fluoride slag; (3) construction of a differential thermal analyzer for determining the solid state transformation temperatures in uranium; (4) physical and chemical property determinations of mullite and alumina refractories by petrographic techniques; (5) classification of normal and enriched uranium reguli by *Archimedes'* principle of bulk density; (6) study of the rolling properties of unalloyed and dilute-alloyed uranium rods in a two-high laboratory rolling mill; (7) tests to determine the optimum operating conditions for machining uranium rods by the flo-peeling process; (8) use of alpha spectrometry for determining the Th 230 and Th 232 ratio in thorium materials; and (9) a low temperature nitric acid leaching process for recovering uranium from $MgF_2$ slag as used in stainless steel plant equipment. K.W.

N67-14688# Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu.
**DETERMINATION OF TUNGSTEN IN IRON BY ACTIVATION ANALYSIS [STANOVENI WOLFRAMU V ZELEZE AKTIVACNI ANALYZOU]**
J. Slunecko, F. Kukula, and M. Simkova Jun. 1966 16 p refs In RUSSIAN
(UJV-1368)

A sensitive method for the nondestructive analysis of W in zone-purified iron by means of the $^{187}W$ isotope is described. For calculation of the W content, 0.48–MeV photons and X-ray peaks at 0.06 keV on the $\gamma$ spectrum were used. By irradiation of the sample in cadmium foils in the thermal channel of the reactor, the activities of $^{59}Fe$ and $^{54}Mn$ were reduced in comparison with the activity of $^{187}W$. The sensitivity of the determination is 0.03 ppM, five times higher than in irradiations without cadmium foils. Author (NSA)

N67-14714# Texas Technological Coll., Lubbock. Center for Molecular Research
**THE REACTIONS OF THIOAROMATIC COMPOUNDS WITH STRONG ACIDS Final Report**
Henry J. Shine [1966] 46 p refs
(Grant AF-AFOSR-23-63)
(AFOSR-66-1932; AD-639685)

The conversion of aromatic sulfides to cation radicals and dications in oxidizing media (principally sulfuric acid) was studied. The structures of the radicals were determined by electron spin resonance spectroscopy. Aromatic sulfoxides in strong acids are converted to the same cation radicals and dications as obtained from the corresponding sulfides. At the same time the aryl rings of the sulfoxide may become hydroxylated. The mechanisms of these reactions have been studied with particular emphasis on heterocyclic compounds such as thianthrene, phenothiazine, phenoxathiin, thioxanthene, and their oxides. The thermal dissociation of a large number of coordination compounds was investigated using the thermal techniques of TGA, DTA, MSA, TMA, X-ray diffraction, and so on. New thermal techniques, such as dynamic reflectance spectroscopy and others, are also described. The photolysis of certain oxalato complexes is also reported. A new type of reaction, thermal matrix reactions, is described and its application to difficult synthetic problems discussed. A four-panel automated research display was fabricated. Author (TAB)

N67-14718# Colorado Univ., Boulder.
**COORDINATION CHEMISTRY OF THE GROUPS IV AND V METALS Technical Documentary Report, 1 Mar. 1962–1 Mar. 1966**
R. N. Keller Wright-Patterson AFB, Ohio, ARL, May 1966 31 p
(Contract AF 33(657)-8321)
(ARL-66-0082; AD-640496) CFSTI: HC $2.00/MF $0.50

It was shown that vanadium(V) (as $V_2O_5$) can be reduced to vanadium(IV) at 80-100°C, with any of the following substances: glycolic, lactic, tartaric, formic, citric, oxalic, and malonic acids; amino acids such as ethylenediaminetetracetic acid, 2-hydroxyethyliminodiacetic acid, methyliminodiacetic acid, nitrilotriacetic acid, and glycine; and hydroxy compounds such as ethylene, propylene glycol, glycerine, and catechol. Most of the reducing agents subsequently react with the vanadium(IV) to form characteristic complexes. The use of $V_2O_5$ has the advantage of allowing the reaction to proceed smoothly and facilitating the preparation of certain complexes containing free carboxyl groups which would be difficult to prepare in any other way. Some of these complexes when dissolved in water titrate as though they are mono- or diprotic acids. Exhaustive efforts in both aqueous and non-aqueous solutions to prepare derivatives of the octafluoroniobate(V) ion failed. Attempts were inconclusive to prepare complexes of niobium(V) and tantalum(V) containing the ion $MX_n(-(n-5))$ (where X is a halogen other than fluorine), and compounds containing a diamide chelating group such as -HNCH2CH2NH-. Author (TAB)

N67-14724# Stanford Research Inst., Menlo Park, Calif.
**KINETICS OF DECOMPOSITION OF AMMONIUM PERCHLORATE Interim Report**
W. A. Rosser, S. H. Inami, and H. Wise 29 Sep. 1966 38 p refs
(Contract Nonr-3415(00))
(PU-3573; AD-640084) CFSTI: HC $2.00/MF $0.50

The decomposition of $NH_4ClO_4$ and of $NH_4ClO_4$-copper chromite mixtures has been studied by isothermal and adiabatic methods. Isothermal experiments resulted in identification of the reaction products and provided kinetic details. Adiabatic experiments provided a description of the rate of decomposition in a mathematical form adaptable to the analysis of combustion phenomena involving $NH_4ClO_4$. Reaction mechanisms for both uncatalyzed and catalyzed decomposition are proposed. Author (TAB)

N67-14732# Eagle-Picher Co., Miami, Okla. Research Labs.
**THE INVESTIGATION OF THE PREPARATION AND EVALUATION OF HIGH PURITY ELEMENTAL BORON Final Report, 1 Aug. 1963–31 Jul. 1966**

J. T. Buford et al 31 Aug. 1966 78 p refs
(Contract AF 19(628)-3259)
(AFCRL-66-581; AD-639646) CFSTI: HC $3.00/MF $0.75

Ultrapure boron was produced via the boron triiodide intermediate. The BI3 was synthesized from crude elemental boron and C.P. grade iodine at various temperatures. A conversion efficiency of 56% was obtained using a charge of -4 +6 mesh boron at a temperature of 900-950°C. Purification of the boron triiodide was performed by distillation in a 30 plate Oldershaw distillation apparatus, by batch zoning of the BI3 matrix, and by vacuum distillation. Thermal decomposition of the distilled BI3 produced boron with approximately 50 ppm carbon as the major impurity. The carbon impurity was measured by a gas chromatographic technique. Boron was crystallized for electrical measurements by vacuum zoning, using induction heating and by melting in a high pressure resistance heated furnace. Using this same high pressure equipment the synthesis of boron phosphide, boron arsenide and boron antimonide was studied. Author (TAB)

N67-14742# Naval Research Lab., Washington, D. C.
**THE ADSORPTION OF CARBON DIOXIDE ON CARBON SOLIDS. PART I: GRAPHITE AND DIAMOND AT 0°C**
V. R. Deitz 11 Jul. 1966 18 p refs
(NRL-6400; AD-639659) CFSTI: HC $1.00/MF $0.50

The high-temperature physical adsorption of carbon dioxide (<<1% coverage) was measured on a number of relatively well defined carbon solids. The results provide an experimental means to differentiate between two arrays of adsorption sites that originate in the strong anisotropy of the graphite structure. The adsorption isotherms at 0°C indicate two distinct regions of surface coverage that are separated by a wide plateau. The adsorption at very low pressures (<0.01 torr) is considered to correspond to high-energy adsorption on an array of edge carbon atoms in the prism faces; the additional adsorption at higher pressures takes place at sites of lesser energy in the more abundant basal planes. Similar behavior was observed for graphitized carbon black FT (2700°C), mineral graphite, an annealed pyrolytic graphite, and a deashed heat-treated (1500°C) coconut charcoal. In contrast, the adsorption of carbon dioxide on purified natural-diamond fragments followed a simple Langmuir isotherm compatible with the known isotropic structure of diamond. The amounts adsorbed expressed per unit area bring out similarities among the carbon solids that are characteristic of graphite. The large adsorption on the coconut charcoal appears due only to the large area that is essentially basal plane in behavior. There is evidence that the pyrolytic graphite has a porosity that may be invaded more completely by carbon dioxide than by krypton. Author (TAB)

N67-14743# Stanford Research Inst., Menlo Park, Calif.
**MEASUREMENT OF THE RECOMBINATION RATE OF $NO^+$ Final Report, 1 Oct. 1964–30 Jun. 1966**
Robert A. Young 1 Jun. 1966 16 p refs
(Contract AF 19(628)-4357)
(AFCRL-66-474; AD-639708) CFSTI: HC $1.00/MF $0.50

The dissociative recombination coefficient of NO(+) with e was measured as (4 plus or minus 1) X 0.0000001 cc/sec. The ions were produced uniformly in space and time in a mixture of N, O, and N2 by chemionization processes. Ion densities were measured by a pulsed total ion collection method. Analysis of the growth of ionization with time and analysis of the dependence of the square of ion density on ion production rate gives essentially identical values for the recombination coefficient. Author (TAB)

N67-14748# IIT Research Inst., Chicago, Ill.
**ADVANCED OXIDIZER CHEMISTRY Technical Summary Report, 1 Apr.–30 Jun. 1966**
Irvine J. Solomon 16 Aug. 1966 33 p refs
(Contract AF 49(638)-1175)
(IITRI-C227-16; AFOSR-66-2056; AD-640405) CFSTI: HC $2.00/MF $0.50

It was found by F18 tracer studies that the compound O2BF4 has the structure O2(+)BF4(-) and not BF3OOF of some other structure. Also, O2BF4 is probably soluble and unreactive in ultra pure HF. Studies of these solutions are being carried out. The O17 and F19 NMR spectra of O2F2 and what has been referred to as O3F2 were studied. The results for O2F2 were as expected: one fluorine line and one oxygen line. For O3F2 three O17 lines were observed; one of the three was shown to be due to O2F2 and the other two, which were of equal intensity, were attributed to O3F2. The F19 spectra of O3F2 consisted of two closely spaced lines and as in the O17 case one of these lines was attributed to O2F2. The NMR shows conclusively that what has been called O3F2 is truly a mixture of O2F2 and O4F2. Author (TAB)

N67-14749# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**COMPUTATION OF THE VIBRATIONAL FREQUENCIES OF A MOLECULE OF HYDRAZIN $N_2H_4$**
Yu. I. Kotov, G. S. Koptev, and V. M. Tatevskiy 25 Apr. 1966 9 p refs Transl. into ENGLISH from Vestn. Mosk. Univ. Ser. II: Khim. (Moscow), no. 3, 1963 p 10–13
(FTD-TT-65-1900; TT-66-62462; AD-640473) CFSTI: HC $1.00/MF $0.50

Results are presented of calculations of the vibrational frequency of a hydrazine molecule for rotational angles of 0,60, 90, 120, and 180 degrees. TAB

N67-14751# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CERTAIN PHOTOCONDUCTIVITY LAWS IN LIQUID ORGANIC SEMICONDUCTORS**
Yu. A. Kopylov and T. N. Trofimova 18 Apr. 1966 15 p refs Transl. into ENGLISH from Izv. Vyssh. Uchebn. Zavedenii, Fiz. (Tomsk), no. 5, 1964 p 28–33
(FTD-TT-65-933; TT-66-62439; AD-640299) CFSTI: HC $1.00/MF $0.50

An investigation was made of the photoconductivity of halide substitutes of methane and benzene and binary systems of these substances with diethyl ether. It was established that positive photoconductivity of the investigated binary systems at definite concentration values of haogeno substitutes are changed by negative photoconductivity. For monocomponent samples photoactivity appears to be radiation close to long wave absorption boundary, while for the binary systems, revealing a negative photoconductivity, photoactivity appears to be radiation lying far beyond the limits of long wave boundary of proper absorption. In the field of absorption band of the system, the nature of negative photoconductivity changes, and for bromobenzene the negative photoconductivity is changed by a positive. Author (TAB)

N67-14830# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
**RECOVERY AND PURIFICATION OF PROMETHIUM-147**
J. T. Lowe *In its* Large Scale Production and Appl. of Radioisotopes May 1966 4 p refs (See N67-14821 05-22) CFSTI: $7.00

A process to reclaim the rare earth fission products as a potential source of $^{147}Pm$ is described. The process is designed to have no significant interference to present plan operation. The rare earth fission products are extracted from Savannah River Plant wastes with 50% tributyl phosphate (TBP) in dodecane. Most of the fission product cerium is oxidized to Ce(IV) through isotopic

exchange with inactive Ce(IV), and is retained in the 50% TBP while the trivalent rare earths (including the $^{147}Pm$) are back-extracted into the aqueous phase. Removal of $^{144}Ce$ eliminates the major source of heat in the rare earth fraction and permits easier storage of the $^{147}Pm$ fraction. After a suitable storage period to permit decay of the undesirable $^{148}Pm$, the $^{147}Pm$ can be purified by ion exchange. Author (NSA)

**N67-14831#** Union Carbide Corp., Oak Ridge, Tenn.
**PREPARATION OF MEGACURIE QUANTITIES OF CESIUM-137 SALTS AND SOURCE COMPOUNDS AT OAK RIDGE NATIONAL LABORATORY**
R. E. Lewis and C. L. Ottinger *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 14 p refs (See N67-14821 05-22) CFSTI: $7.00

Processes used for recovery, purification, and conversion of megacurie quantities of $^{137}Cs$ to salts and source compounds are reviewed with special emphasis on the conversion of cesium alum to cesium carbonate by the cesium tetraoxalate process. Subsequent conversion of cesium carbonate to source compounds is discussed. Author (NSA)

**N67-14832#** Commissariat a l'Energie Atomique, Saclay (France).
**"ELAN"--INSTALLATION FOR THE RECOVERY AND PACKAGING OF CAESIUM 137 IN FRANCE**
A. Raggenbrass, J. M. Courouble, J. Lefevre, J. Fradin, and C. Perebaskine *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 10 p refs (See N67-14821 05-22) CFSTI: $7.00

A facility constructed for the purpose of testing cesium 137 production is described. Direct recovery of the cesium is obtained by ion exchange from concentrated acid solutions of fission products. Three inorganic ion exchangers (PWZr, PMoZr, and PTi) are mentioned, and a table of comparative properties of the exchangers is presented. Consideration is also given to the various manufacturing stations and the cesium compounds which can be synthesized. A.G.O.

**N67-14833#** Union Carbide Corp., Oak Ridge, Tenn.
**CURIUM PROCESSING EXPERIENCE**
V. C. A. Vaughen and R. D. Baybarz *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 12 p (See N67-14821 05-22) CFSTI: $7.00

About 35 g each of curium-244 and americium-243 were prepared in pure form, and about 12 g of curium-242 were also prepared. Processes were demonstrated to yield recoveries of about 95% across the two-cycle (Clanex–Tramex) process with demonstrated decontamination factors of up to 500 for gross gamma, 2000 for ruthenium-106 and europium-154, and 3000 for cerium-144. Ionic purity was suitable for source fabrication. Final purification and separation of curium-244 from americium-243 yielded an americium product of better than 99.9% purity and a curium product containing about 0.5 wt % americium. Beta-gamma emitting contaminants were below detectable limits. Author (NSA)

**N67-14834#** Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
**CHEMICAL PROCESSING OF CURIUM STATUS OF PILOT PRODUCTION PROGRAM AT SAVANNAH RIVER**
R. B. Nael, I. D. Eubanks, M. C. Thompson, and G. A. Burney *In its* Large Scale Production and Appl. of Radioisotopes May 1966 8 p ref (See N67-14821 05-22) CFSTI: $7.00

A process for purifying $^{244}Cm$ produced in Savannah River reactors was successfully demonstrated in the laboratory. Radiochemically pure curium was produced in pilot demonstrations that are adaptable to large-scale production. Improvements were made in the processing scheme that simplify chemical processing without sacrificing product quality. Actinide–lanthanide partitioning by solvent extraction with tertiary amines in a chloride system was successfully demonstrated. Recent improvements permit extended reuse of the solvent and removal of californium from the curium product. Several methods for minimizing radiation effects in process solutions were developed. Thermogravimetric studies defined the calcination temperatures for producing curium dioxide as the final product. NSA

**N67-14836#** Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
**CHEMICAL SEPARATION OF REACTOR-PRODUCED TM-171**
W. C. Perkins *In its* Large Scale Production and Appl. of Radioisotopes May 1966 4 p refs (See N67-14821 05-22) CFSTI: $7.00

The development of a recovery process for the separation of Er and Tm is reported. Erbium oxide and erbium metal were irradiated at the Savannah River Plant to produce $^{171}Tm$. Erbium oxide was then used to test the ion exchange separation technique. Approximately 8 mg of the $^{171}Tm$ was separated from the dissolved $Er_2O_3$ targets by chromatographic elution from cation exchange resin with hydroxy ethyl ethylene diamine triacetate (HEDTA). The $^{171}Tm$ was recovered from the product solution by precipitation as the oxalate, which was decomposed to $Tm_2O_3$, an acceptable form for encapsulation. NSA

**N67-14837#** Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
**THE LARGE SCALE SEPARATION OF POLONIUM-210 FROM BISMUTH**
A. S. Jennings, J. F. Proctor, and L. P. Fernandez *In its* Large Scale Production and Appl. of Radioisotopes May 1966 24 p refs (See N67-14821 05-22) CFSTI: $7.00

A prospective vacuum distillation process and related equipment are described for the large-scale separation of polonium-210 from irradiated bismuth. The polonium will be concentrated to greater than 95 wt % from a bismuth feed containing between 25 and 75 ppm polonium. Compared with aqueous processes, the advantages of vacuum distillation are: a high throughput in equipment of modest size, ready purification of both polonium and bismuth products, while at the same time avoiding the reduction of polonium and bismuth salts back to the metallic form. Author

**N67-14890*#** Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
**ATOM FORMATION RATES BEHIND SHOCK WAVES IN HYDROGEN AND THE EFFECT OF ADDED OXYGEN, JULY 1966-JULY 1966**
A. L. Myerson, W. S. Watt, and P. J. Joseph Nov. 1966 31 p refs
(Contract NASr-109)
(NASA-CR-80966; CAL-AD-1689-A-7) CFSTI: HC $3.00/MF $0.65 CSCL 07D

A direct isothermal measurement has been made of the rate of formation of atomic hydrogen behind shock waves in hydrogen–argon mixtures. This has been accomplished by using atomic resonance absorption spectrophotometry in the vacuum ultraviolet. The observations were made in an ultrahigh-purity shock tube. The sensitivity afforded by the technique and the simplicity of the interpretation bespeak a high degree of accuracy for the measurement. Because of the sensitivity, it was also possible to determine quantitatively the catalytic effect of the addition of small amounts of oxygen. These observations have led to an unequivocal measurement of the rate of the limiting step $H+O_2 \rightarrow OH+O$ in the mechanism of the $H_2$–$O_2$ reaction under the conditions of the experiment. Author

N67-14895*# Aero Vac Corp., Troy, N. Y.
**EFFECT OF LOW DENSITY INERT GAS FLUSH ON OXYGEN–COLUMBIUM REACTION AT 1500°F TO 2000°F Final Report**
4 Nov. 1966 24 p refs
(Contract NASw-722)
(NASA-CR-80960) CFSTI: HC $3.00/MF $0.75 CSCL 07A

A new process for testing columbium–1% zirconium and similar alloys heated to 1000°C was investigated. The process involved use of a controlled flowing high purity gas at a subatomospheric pressure to provide work space with a desired environment. The purity of the environment was determined by the contaminant partial pressure. The advantage of this process over former techniques is the ability to achieve wide ranges of impurity pressures at a minimum of gas flow and equipment cost. A system consisting of a gas purifier, a furnace designed for gas purge operation, a vacuum system to house the furnace, and a specially designed gas analysis system was fabricated. The gas analysis data indicated higher contaminant concentrations than were expected to result from the purification system. It is concluded that the subatmospheric inert gas flush process is a simple inexpensive method of obtaining high purity environments. The purity obtained with an inert gas process system is superior to the atmospheric testing processes. S.P.

N67-14945# Space-General Corp., Los Angeles, Calif. Center for Research and Education.
**ANALYSIS OF BORANES AND CARBORANES BY MASS SPECTROMETRY**
J. F. Ditter, F. James Gerhart, and Robert E. Williams 12 Oct. 1966 33 p refs Submitted for Publication
(Contract Nonr-4381(00))
(SGC-482-10; TR-10; AD-641578) CFSTI: HC $2.00/MF $0.50

Boranes and carboranes each have their own characteristic mass spectral patterns which serve as means for quick identification and analysis. The so-called stable boranes fragment rather severely under electron impact, the unstable boranes even moreso. Both types have broad, rounded spectral profiles. Closocarboranes which are a very stable class of compounds, on the other hand, are very resistant to fragmentation, and consequently display sharp cut-offs at their high mass numbers. Alkylated derivatives of both boranes and carboranes have the same general fragmentation patterns as do their nonalkylated parents. A useful mass spectrometric technique applicable to these compounds to determine the number of boron and carbon atoms involves careful measurement of the 13C-containing ion that appears above the normal cut-off peak. The method is illustrated with C4B6H12, the dimethyl derivative of the carborane, C2B6H8. Author (TAB)

N67-14984# Walter Reed Army Medical Center, Washington, D. C. Medical Biomechanical Research Lab.
**GAS–LIQUID CHROMATOGRAPHY OF THE ALKYL ALPHA CYANOACRYLATES**
Duane E. Bartak and R. K. Kulkarni Aug. 1966 15 p refs
(TR-6614; AD-641120) CFSTI: HC $1.00/MF $0.50

The purity of the cyanoacrylate monomers was estimated by gas-chromatographic technique. Some of the impurities, like diglyme, cyanoacetates, were identified by noting the retention volumes. A plot of the retention volumes vs. number of carbons in the alkyl part of the cyanoacrylates was found to be linear; however, the use of temperature programming to obviate the broadening of the peaks for compounds having higher retention volumes was not successful, due to the shifting of the base line with increase in temperature. Author (TAB)

N67-15005# Frankford Arsenal, Philadelphia, Pa.
**STRUCTURAL EFFECTS OF ARYLSTEARIC ACIDS AS COMBINATION OXIDATION AND RUST INHIBITORS**
Jonathan L. Snead, Joseph Messina, and Henry Glaser Sep. 1966 7 p refs
(FA-A66-11; AD-642294)

Effect of variation in molecular configuration of hydroxy-arylstearic acids on effectiveness as combination oxidation-rust inhibitors in bis (2-ethylhexyl) sebacate was studied. Alkyl groups ortho and para to the hydroxyl of 9 (or 10)-hydroxy-arylstearic acids enhanced oxidation protection but decreased rust protection somewhat. A second hydroxyl on the aryl ring—e.g., 9 (or 10)-(2,3-dihydroxyphenyl) stearic acid—yielded still better oxidation protection, while 9,12-bis (4-hydroxyphenyl) stearic acid was the best antioxidant, with only a slight compromise in rust protection, of those studied. Alkaline earth soaps of the compounds were also effective combination inhibitors. The additives described are generally good antioxidants up to 175°C, effectiveness decreasing with increasing temperature, and they provide adequate protection against rust. Author (TAB)

N67-15022# Chicago Univ., Ill. Div. of the Physical Sciences.
**EXPANDED RESEARCH PROGRAM IN MATERIALS SCIENCES Fifth Annual Technical Report, 1 Jul. 1965–30 Jun. 1966**
26 Jul. 1966 100 p refs
(Contract ARPA SD-89)
(AD-640485) CFSTI: HC $3.00/MF $0.75

The report lists all research in the field of materials science and includes pertinent administrative data within the following divisions: the Department of Chemistry, the Department of Geophysical Sciences, the Department of Physics, the Institute for the Study of Metals, and the Enrico Fermi Institute for Nuclear Studies. TAB

N67-15051# Naval Air Engineering Center, Philadelphia, Pa.
**A RADIOCHEMICAL INVESTIGATION OF THE LEACHING OF CHROMIUM FROM CHEMICALLY CHROMATED ALUMINUM SURFACES**
A. L. Glass 19 Jul. 1966 28 p refs
(NAEC-AML-2478; AD-640437) CFSTI: HC $2.00/MF $0.50

A reproducible and accurate radioactive tracer procedure using the isotope chromium-51 has been developed to measure the 'leaching' rates, in situ, of chromium from chemically chromated aluminum surfaces. Studies of the rates of solution are reported and an interpretation of these results is presented. Author (TAB)

N67-15080# Syracuse Univ., N. Y. Dept. of Chemistry.
**FLUCTUATION PHENOMENA NEAR PHASE TRANSITIONS IN CONDENSED SYSTEMS Annual Technical Report, Oct. 1965–Oct. 1966**
Harry Brumberger 15 Oct. 1966 44 p refs
(Contract Nonr-669(19))
(TR-2; AD-642086) CFSTI: HC $3.00/MF $0.85

Results of X-ray critical opalescence measurements at very small scattering angles are reported for the nitrobenzene–n–heptane system. Progress in the computer calculation of slit corrections for small-angle X-ray measurements is discussed. Some experimental observations on the alpha–beta quartz transition and on the demixing region of the liquid sodium–lithium system are also reported and analyzed, as are some of the experimental techniques for handling these liquid metal mixtures. The current status and future plans for these projects are reviewed. Author (TAB)

N67-15095# Naval Research Lab., Washington, D. C.
**KINETICS OF EXCESS SOLUTE PRECIPITATION IN LIQUID SODIUM SOLUTIONS Final Report**

T. A. Kovacina, P. G. Johnson, and R. R. Miller 1 Sep. 1966 15 p refs
(NRL-6424; AD-642332) CFSTI: HC $3.00/MF $0.65

The precipitation characteristics of excess silver and calcium solutes in their respective liquid sodium solutions were studied in the temperature range of 425 to 150° C and the concentration range of approximately 20.0 to 0.10 weight-percent of solute. The excess solute was observed to precipitate out of the bulk of the respective solution as rapidly as the temperature was reduced. The data obtained best fit the empirical equation Co-CT/Co =(Dt × Dt)k/d sq., where Co is the initial solute saturation (number of atoms per gram of sodium) and Ct is the concentration at any subsequent lower temperature. The quantity (Co–Ct)/Co is then the fraction of the total solute that precipitated out of solution; this excess was observed to be directly proportional to the product of the temperature decrement dt(dec. c) and corresponding elapsed cooling time dt (min) and inversely proportional to the square of the interatomic solute distance d(cm). The factor K is a proportionality factor assumed to be nearly constant over the concentration and temperature range of the solutions investigated. Author

N67-15116# Texaco Experiment, Inc., Richmond, Va.
**DECOMPOSITION CHEMISTRY OF $NF_2$ COMPOUNDS Final Report**
P. L. Goodfriend and H. P. Woods Aug. 1966 25 p refs
(Contract Norv-1883(00))
(TP-283; EXP-223; AD-642190) CFSTI: HC $3.00/MF $0.65

Work included: Investigations of the flash photolysis-kinetic spectroscopy of NF3, N2F4=2NF2, HNF2, ClNF2, and FNC12; studies of the emission spectra of electrical discharges through NF3 and N3F4=2NF2 and of flames of NF-containing oxidizers; attempts to follow the kinetics of the NF radical by means of flash photolysis-kinetic infrared spectrophotometry. The more significant results of these investigations were: elucidation of the 2600A absorption NF2; a useful apparatus for flash pholysis-kinetic spectroscopy in the vacuum ultraviolet; discovery of a transient absorption spectrum in the flash photolysis of HNF2 and assignment of the carrier as the HNF radical; discovery of an unidentified transient spectrum in the flash photolysis of FNC12; discovery of two bands in the emission spectra of flames of NF containing oxidizers which proved to be bands of the NF radical emission spectrum. Author (TAB)

N67-15153*# Gulton Industries, Inc., Metuchen, N. J. Alkaline Battery Div.
**INVESTIGATION OF BATTERY ACTIVE NICKEL OXIDES Final Report**
P. Ritterman, S. Lerner, and H. N. Seiger 12 Sep. 1966 127 p refs
(Contract NAS3-7620)
(NASA-CR-72128) CFSTI: HC $3.00/MF $1.30 CSCL 07D

A study of the structures of the compounds formed on a nickel oxide electrode with respect to charged stand, charge rate, state of charge and during overcharge was made by using X-ray diffraction, chemical analysis and spectroscopy. It was found that the structure of the discharged state corresponds to ordered $Ni(OH)_2$ and that this structure persists until the electrode is close to the fully charged state. At this point, the structure decays into a randomized NiOOH structure which is essentially amorphous to X-ray diffraction techniques. Continued high rate overcharging recrystallizes the amorphous material into what is called the γ-NiOOH structure. Experiments for stabilizing the sintered plate nickel oxide electrode by means of formation at various rates and temperatures were performed. The effects of the inclusion of various metal additives to the active material was also investigated as a method of high temperature stabilization. Author

N67-15161# Joint Publications Research Service, Washington, D. C.
**RECENT SOVIET STUDIES IN ORGANIC CHEMISTRY. REACTION OF DIETHYLCHLOROPHOSPHINE WITH DERIVATIVES OF ALPHA, BETA-UNSATURATED ACIDS. ORGANIC INSECTOFUNGICIDES. XCIX: CHLORANHYDRIDES OF O-ARYLMETHYLTHIOPHOSPHONIC AND CHLOROMETHYLTHIOPHOSPHONIC ACIDS**
V. S. Tsivunin, G. Kh. Kamay, S. Kh. Nurtdinov, N. N. Mel'nikov, A. F. Grapov et al 20 Dec. 1966 12 p refs Transl. into ENGLISH from Zh. Obshch. Khim. (Moscow), v. 36, no. 10, Oct. 1966 p 1827–1830, 1841–1843
(JPRS-39189; TT-66-35611) CFSTI: $1.00

An investigation was made of the reaction of diethylchlorophosphine with the chloranhydride of crotonic acid. It was found that on mixing the components in heptane, an exothermal reaction takes place with the formation of a white, crystalline adduct. The subsequent decomposition of the adducts with alcohols leads to the formation of esters of beta methyl beta diethylphosphonapropionic acid. It was also found that decomposition of these adducts with alpha, beta-unsaturated acids leads to products of phosphine oxides, and that decomposition of chloranhydride adducts with ethylmercaptane leads to products of thio-oxides. Included is the development of a method for synthesizing O-arylmethyl- and chloromethylthiophosphonic acids by the reaction of equimolecular amounts of dichloranhydrides of the corresponding thiophosphonic acids with phenols in the presence of triethylamine. C.T.C.

N67-15165# Joint Publications Research Service, Washington, D. C.
**TRANSLATIONS ON COMMUNIST CHINA'S SCIENCE AND TECHNOLOGY, NO. 358. THE FOUR ACIDS AND THE THREE ALKALINES**
Te-Pang Hou and Hsien-Kang Hu 28 Dec. 1966 93 p Transl. into ENGLISH of the book "Szu Suan San Hsien" Peking, Popular Sci. Publishing House, Mar. 1966 p 1–153
(JPRS-39267; TT-66-35689) CFSTI: $3.00

A discussion is given of the basic chemical industry which deals with the seven most used acids and alkalines. These include sulfuric acid, nitric acid, phosphoric acid, caustic soda, hydrochloric acid, soda ash, and washing soda. The discussion categorically introduces the production history, and includes consideration of raw materials, processes, principles, varieties, properties, and applications. C.T.C.

N67-15166# Joint Publications Research Service, Washington, D. C.
**NITRATES AND PERCHLORATES OF NITROGEN-CONTAINING BASES**
L. S. Korablina, V. D. Krylov, L. M. Kharchevnikova, and V. V. Yastrebov 28 Dec. 1966 7 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Khim. i Khim. Tekhnol. (Moscow), v. 9, no. 3, 1966 p 351–354
(JPRS-39282; TT-66-35704) CFSTI: $1.00

The roentgenographic characteristics of the following substances were determined: mono- and dinitrate of hydrazone, hydrazone perchlorate, and nitroaminoguanidine. It is noted that the chlorates of dimethyl hydrazone and of nitrosaminoguadinine are described for the first time in the chemical literature. C.T.C.

N67-15289*# Grace (W. R.) and Co., Clarksville, Md.
**SYNTHESIS OF LINEAR, DOUBLE CHAIN, LADDER POLYMERS FROM SUBSTITUTED TETRAPHOSPHONITRILES Quarterly Progress Report, Sep.–Nov. 1966**

Bernard Grushkin, Robert M. Murch, T. S. Soddy, and T. Bieniek
Nov. 1966 26 p refs
(Contract NASw-1415)
(NASA-CR-81137) CFSTI: HC$3.00/MF$0.65 CSCL 07C

During this reporting period the thermal polymerization of *β-trans*-$[OPN(NH_2)]_4$ was investigated at temperatures ranging from 209° to 320°C. Highest number average molecular weight of 36,000 was obtained when the deammoniation was carried out at 265°C. The following monomers have been prepared and are now being used for polymerization studies: $[OPN(N_3)]_4$, $[OPN(NCS)]_4$ and $[OPN(NHCH_3)]_4$. Thermal deamination of the tetrakismonomethylamide resulted in lower molecular weight polymers. By heating the tetraazide, nitrogen is evolved and a polymeric material is produced. Author

**N67-15292#** Rock Island Arsenal Lab., Ill. Research and Engineering Div.
**REACTIONS OF POTENTIALLY SUITABLE VCI COMPOUNDS WITH NONFERROUS METALS**
Peter Martin, Jr. Jul. 1966 20 p refs
(RIA-66-2246; AD-639949) CFSTI: HC$1.00/MF$0.50

Restrictions currently exist in the use of volatile corrosion inhibitors (VCI) because of the adverse effects on some nonferrous metals and nonmetals. Work was initiated to develop VCIs which would be inert or passive to both nonferrous metals and nonmetals but still have the ability to vaporize to combat a corrosive environment. Possible VCI compounds were selected and their vapor pressures were measured by the Torsion-Effusion method. Vapor pressure data was obtained for amines of the nitrites, carbonates, benzoates, chromates and caprylate at 21 C. Values ranged from <0.00001 to 0.0048 mm of Hg. Vapor pressure-temperature curves were determined for benzylamine carbonate and dicyclohexylamine caprylate. Reactivity tests were conducted showing the nature and intensity of the attack of the VCI compounds on nonferrous metals. The test consisted of exposing Cu, Cd, Mg, Zn and Al specimens to the VCI compounds for 7 days at 150 F. in the presence of high humidity. Weight loss measurements were used to evaluate the attack on the metals in mils penetration per year (mpy). On the basis of the results obtained the following conclusions were made. (a) Cadmium and magnesium are more severely attacked by the VCI compounds in the presence of water vapor than the other metals tested. (b) there is not one of the VCI compounds which decreases the corrosion rate of all the metals tested or which has the least corrosive effect and (c) no correlation was found between the vapor pressures and the reactivity with nonferrous metals. Author (TAB)

**N67-15302#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THERMAL DEGRADATION OF POLYETHYLENE**
N. A. Slovokhotova, M. A. Magrupov, and V. A. Kargin 6 Apr. 1966 16 p refs Transl. into ENGLISH from Vysokomolekul. Soedin. (Moscow), v. 6, no. 11, 1964 p 1974–1979
(FTD-TT-65-1691; TT-65-13418; AD-640286) CFSTI: HC $1.00/MF$0.50

The thermal degradation of high and low pressure polyethylene (HPPE and LPPE) at temperatures from 325 to 415C was investigated under vacuum in a closed system and under conditions of removal of the volatiles from the reaction space. An IR spectrum analysis of the degradation products demonstrated that when the reaction is carried out in the closed system at 380C and higher, secondary reactions between the pyrolysis products leading to increase in trans-vinylene and decrease of vinyl unsaturation become of importance. The increase in the relative number of trans-vinylene double bonds in the PE pyrolysis products is not in accord with the scheme of formation of such bonds in degradation of the polymeric chain at the free radical center close to the branching node of the chain. It is suggested that trans-vinylene double bonds are formed as the result of migration of the end double bonds to the middle of the chain, and also of intramolecular encounter of two free radical centers. It was found that inorganic impurities in PE effect the distribution of the unsaturation in its thermal degradation products. The reason for the higher thermal resistance of LPPE than HPPE is discussed. Author (TAB)

**N67-15308#** Sheffield Univ. (England). Dept. of Chemistry.
**A STUDY OF THE HALOGENATION OF ALIPHATIC HYDROCARGONS AND DERIVATIVES THEREOF**
J. M. Tedder and P. S. Fredricks [1959] 20 p refs
(Contract AF 61(052)-63)
(TN-1; AD-639937) CFSTI: HC$1.00/MF$0.50

The halogenation of the n-butyl halides in the gas phase was investigated. To date the fluorination of n-butyl fluoride and the chlorination of n butyl fluoride, chloride and bromide were investigated. It is hoped to extend these investigations to include a study of the bromination of these compounds under similar conditions. The results obtained so far indicate that the effect of the halogen already present in the organic molecule is to retard substitution at the (beta-carbon atom, the effectiveness of the halogens being the order F > Cl > (Br); there is some evidence that fluorine may deactivate the gamma-position slightly. At present it has only been possible to obtain precise data about substitution at the alpha-carbon atom in chlorination, which is slightly retarded at this position, the effectiveness of the substituent halogens in deactivation being Br > Cl approx. = F. The selectivity of the attacking atoms is Cl > F but they appear to be affected to a different extent by the substituent halogen. Thus fluorination, while remaining far less selective than chlorination, appears to be more affected by the substituent halogen. Some preliminary studies on the effect of other substituents than the halogens were made. Author (TAB)

# 07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

**N67-14351#** Joint Publications Research Service, Washington, D. C.
**PROBLEMS IN OPTIMIZATION OF RECOGNITION OF OBJECTS AGAINST NONHOMOGENEOUS BACKGROUNDS**
R. L. El'man *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 114–121 refs (See N67-14341 05-10)

The variation method for solution of the problem of optimal recognition of objects belonging to m classes among foreign objects of the background is investigated. It is shown that with a background abounding in objects and in cases where the distribution of the image points of the true objects of each class in the space of the signs is subject to an n-dimensional normal law, the quadratic selector is optimal. Author

**N67-14352#** Joint Publications Research Service, Washington, D. C.
**AUTOMATIC VOICE RECOGNITION**
G. S. Ramishvili *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 122–131 refs (See N67-14341 05-10)

Experiments have been described with respect to automatic recognition of the voices of speakers reading some text. Two

procedures are investigated. The first uses fixed speech segments. Here the informativeness of the speech sounds is evaluated in advance. The most useful segment of the spectrum for recognition of voices is established, and the band spectral analysis of the speech signal is carried out. The recognition process is carried out with the help of a computer. The second procedure is based on the statistical parameters of the speech signal and does not require identification of the text. As the parameter the distribution of the intervals between the extrema of a sufficiently long segment of the speech signal is taken. Author

**N67-14353#** Joint Publications Research Service, Washington, D. C.
**SPEECH RECOGNITION WITH THE HELP OF ITS PATTERN ANALYSIS**
V. N. Sorokin *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 132–138 refs (See N67-14341 05-10)

On the basis of the investigation of different models of the voice apparatus it has been established that an adequate representation of a speech signal is visible speech. The conclusion has been drawn of the possibility of recognition of pictures of visible speech by the methods of pattern recognition. Author

**N67-14357#** Joint Publications Research Service, Washington, D. C.
**THE MINIMAX APPROACH TO THE SOLUTION OF THE INFORMATION PROCESSING PROBLEM**
V. M. Aleksandrov *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 178–192 refs (See N67-14341 05-10)

The minimax approach to the solution of the problem of extraction of the useful signal against the background of noise in the form of white noise is investigated. On the basis of the Pontryagin maximum principle, necessary and sufficient minimax conditions are derived. It is shown that for the given problem the minimax approach is equivalent to the maximin approach. An example is presented for calculation of the minimax. Author

**N67-14366#** Compagnie Francaise Thomson-Houston, Paris (France).
**AUGMENTATION OF THE POWER SEPARATER OF AN ANTENNA FOR DECOMPOSITION OF A FIELD RECEIVED IN ORTHOGONAL DISTRIBUTIONS [AUGMENTATION DU POUVOIR SEPARATEUR D'UNE ANTENNE PAR DECOMPOSITION DU CHAMP RECU EN DISTRIBUTIONS ORTHOGONALES]**
S. Drabowitch and M. Mathais [1966] 71 p refs In FRENCH Presented at AGARD Congr., Duesseldorf, 7–13 Jul. 1966

The resolving power increase of an orthogonal distribution, field resolution antenna is discussed. A new method is presented which permits measuring the angular deviation of two objects when the deviation is very inferior to the amplitude of the diffraction lobe. Technique, instrumentation, mathematical expressions, and other technical data are included together with numerous graphs and pertinent photographs. Results obtained agree with the information theory and show an appreciable power gain in relation to Rayleigh's theory. Transl. by R.Li.

**N67-14421*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**SPACE PROGRAMS SUMMARY NO. 37-41, VOLUME III FOR THE PERIOD JULY 1, 1966 TO AUGUST 31, 1966. THE DEEP SPACE NETWORK**
30 Sep. 1966 212 p refs
(Contract NAS7-100)
(NASA-CR-80684; JPL-SPS-37-41, Vol. III) CFSTI: HC $4.25/MF $1.50 CSCL 09F

Articles on tracking and navigational accuracy analysis, communications research and development, communications development engineering, and Deep Space Station engineering and operations are presented. For individual titles see N67-14422–N67-14457. Author

**N67-14422*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**DSIF TWO-WAY DOPPLER INHERENT ACCURACY LIMITATIONS. III: CHARGED PARTICLES**
D. W. Trask and L. Efron *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 9 p refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

The effect of charged particles which exist in the ionsphere and the space plasma between the spacecraft and the tracking station are discussed. A set of standard data taking conditions was selected to illustrate the inherent accuracy limitations on two-way Doppler. These errors are expressed in terms of their contribution to the range difference derived from counting the Doppler tone over $10^4$ sec. This relatively long count time is chosen to show the advantage of continuously accumulating Doppler in the presence of bounded errors such as spacecraft limit cycle motion, Doppler counter quantization, and system phase jitter. The count time is made large to reduce correlations of successive data points. Examples of the occurrence of relatively long correlation widths include the deviation between the real universe and the fitters model of atmospheric corrections and of the relations among station time tags, universal time, and ephemeris time. The count interval is assumed to be centered about the zenith, which minimizes the effects of atmospheric refraction. Both lunar and planetary missions are considered. R.N.A.

**N67-14423*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**A STUDY OF PLANETARY-APPROACH ORBIT-DETERMINATION POLICIES USING MARINER IV DOPPLER DATA**
G. W. Null *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 12–18 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

During the Mariner IV Mars mission, highly accurate two-way Doppler tracking data were taken by the Deep Space Network. This article presents the orbit determination target error results obtained by analyzing the tracking data from Mars encounter (E) −5 days to the following times: E−72H, E−48H, E−24H, E−17H, E−5H, E−1H, E−0.3H, and E+0.25H. A weighted least squares single precision orbit determination program was used for the analysis. The quantities of interest are the predictions of the following closest approach quantities: B=a vector from the center of Mars normal to the incoming asymptote $B \cdot T_c$, $B \cdot R_c$ where $T_c$ is a unit vector in the plane of the ecliptic normal to the incoming asymptote S. $R_c$ makes up a right handed RST coordinate system. For Mariner IV, $R_c$ is very nearly normal to the elliptic plane. The errors in time of closest approach are investigated. The evaluation of the target point prediction error, as a function of time, is accomplished by assuming that the true target point may be obtained by fitting data from E−5 days to E+5 days. The astronomical unit was determined to within ±500 km of 1$\sigma$ and the gravitational constant of Mars to within ±8 $km^3/sec^2$. R.N.A.

**N67-14424*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**TIMING DATA AND THE ORBIT DETERMINATION PROCESS AT JPL**
P. M. Muller *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 18-24 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

Samples of bimonthly summaries of time-data necessary to the real time orbit determination program process are illustrated. Fairly adequate predictions of future conditions are generated. Necessary time corrections require polynomial approximations to

real UTI, UTC, and ET. A computer program, TPOLY, is described which produces a convenient listing of raw data and auxiliary quantities, a set of polynomials which fit the data, and a punched deck which initializes the orbit determination program with respect to time handling. The current methods of handling timing problems are outlined and consideration is given to the direction of future effort. R.N.A.

**N67-14425*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**THEORETICAL BASIS FOR THE DOUBLE PRECISION ORBIT DETERMINATION PROGRAM (DPODP). III: PROBE TRAJECTORY**
T. D. Moyer *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 24–31 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

The differential equations of motion of the probe which are integrated numerically in a rectangular coordinate system to give the probe ephemeris with ephemeris time are described. The equations for computing each term of the total probe acceleration relative to the center of integration are given. These consist of Newtonian point mass acceleration, oblate body acceleration, acceleration due to solar radiation pressure and attitude control, and acceleration due to motor burn. Precomputed position and velocity ephemerides for the celestial bodies with the solar system are available. For three of these precomputed ephemerides, the orbital elements of an osculating conic at some epoch are solved for parameters. The ephemeris correction consists of the difference between the solve for conic and the osculating conic. Formulas for correcting the basic ephemerides and for computing the corrected position and velocity of the sun, moon, or a planet relative to any other of these bodies are given. These quantities are required to compute the probe acceleration terms, at phase changes, and at the injection epoch, if the injection position and velocity are referred to a body other than the center of integration. R.N.A.

**N67-14426*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**THEORETICAL BASIS FOR THE DOUBLE PRECISION ORBIT DETERMINATION PROGRAM (DPODP). IV: LIGHT TIME SOLUTION**
T. D. Moyer *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 31–38 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

The formulation for solving the light time problem, which is the first step in the computation of all observable quantities, is presented. An electromagnetic signal is transmitted from a tracking station at time $t_1$. This signal is received by the probe and retransmitted at time $t_2$, arriving at the same or different tracking station at time $t_3$. The transmitting and receiving station(s) and the probe are direct participants, and $t_1$, $t_2$, and $t_3$ are the epochs of participation of each participant. The solution consists of the heliocentric position, velocity, acceleration, and jerk of each direct participant evaluated at its epoch of participation. The solution is obtained by solving the light time equation for each leg of the path of electromagnetic radiation from the transmitting to the receiving station. Starting with the known reception time $t_3$, the light time equation is solved by an iterative technique for the down leg of the light path to give the epoch of participation for the probe, $t_2$. Given $t_2$, the light time equation is solved iteratively for the up leg of the light path to give the transmission time $t_1$. R.N.A.

**N67-14427*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**RANGE AND ANGLE CORRECTIONS DUE TO THE IONOSPHERE**
A. Liu *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 38–41 ref (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

Radio waves passing through an ionosphere are not only deflected from a straight line, (refracted), but also the speed at which the wave is propagated is altered. The ionospheric effects turn out to be more severe for missions to the inner planets than for missions to the outer planets. The reason is that for missions to Venus, for example, the observations are always taken more nearly in the direction of the Sun, and hence, through a much thicker ionosphere than for observations taken for a Mars mission, where for about half the duration of the mission, the measurements are taken at night. A program was written to ray-trace through a Chapman ionosphere, and curves are presented to illustrate the effects of variations in the ionospheric model upon the range and angular measurements as a function of elevation angle. Author

**N67-14428*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**APOLLO PROJECT SUPPORT**
D. W. Curkendall *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 41–42 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

Brief descriptions are presented of specific studies which were conducted under an Apollo project support task. This task has as its objectives to provide the systems analysis effort to support the development of unified S-band to be used in the Apollo program, to develop the capability of participating the Apollo S-band qualification tests, and to assist in the planning and execution of the navigation aspects of the Apollo lunar landing mission. R.N.A.

**N67-14429*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**THE INFLUENCE OF OSCILLATOR INSTABILITY ON ORBIT ACCURACY**
D. W. Curkendall *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 42–47 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

Consideration is given to the Doppler data noise model and its relation to orbit accuracy. The influence of the oscillator stability on the data is analyzed assuming that the oscillator generates white frequency noise. Both two- and three-way Doppler are investigated and it is shown that while the oscillator frequency noise is impressed directly onto the three-way data, a transformation to colored phase noise takes place when considering the two-way configuration. The importance of this difference is discussed. R.N.A.

**N67-14430*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**APPLICATION OF A BOUNDED RANGE ERROR MODEL TO THE EVALUATION OF THE INFORMATION CONTENT OF A SINGLE PASS OF DOPPLER DATA**
D. W. Curkendall *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 47–50 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

An uncorrelated phase noise Doppler model is applied to the three-dimensional navigation problem first analyzed by Hamilton and Melbourne using the white frequency noise model. The results obtained, which indicate a significant increase in accuracy over those obtained by Hamilton and Melbourne, are related to the oscillator error source equations, and it shown that the information content in a single pass of Doppler data is inversely proportional to the round trip light time to the probe when oscillator noise is the dominant error. R.N.A.

**N67-14431*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**ORBIT DETERMINATION OF TWO SPACECRAFT THROUGH THE USE OF EARTH-BASED MULTIPLE-LINK DOPPLER TRACKING DATA**
D. W. Curkendall *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 50–58 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

A study is presented of the navigational accuracy resulting when multiple link Doppler is obtained by coherently transmitting from the earth to the first spacecraft, to the second, and back to earth. Three examples of performance are discussed. The first analyzes a direct LEM ascent to a rendezvous with the CSM. The addition of the multiple link data results in an orbital accuracy improvement of a factor of five over that using two- and three-way Doppler alone. However, if the three-way data is deleted, the improvement factor is approximately 50, suggesting that multiple link data can supplant the function of three-way data for a rendezvous at interplanetary distances. The second example analyzes the case of tracking a spacecraft behind the moon using a lunar communications satellite as a coherent relay for the tracking signal. Entirely adequate orbital estimates can be obtained before direct contact is made with the spacecraft. The third case examines the tracking of a released capsule lander and its parent spacecraft for an interplanetary mission. The multiple link data cannot establish the spacecrafts' orbits much better than two-way data alone, but their relative orbits can be precisely determined if the interspacecraft link is added. R.N.A.

**N67-14432*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**PIONEER PROJECT SUPPORT**
D. W. Curkendall *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 56–57 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

The Deep Space Network is committed to track the Pioneer spacecraft, obtain engineering and scientific telemetry, determine the orbit of each probe, and provide facilities for the conduct of the mission and reduction of data. Three studies conducted in support of these commitments are briefly summarized. They deal with an analysis of a sinusoidal periodicity found in the Pioneer VI doppler tracking data, an analysis relating injection dispersions due to launch vehicle guidance errors to the initial tracking station's acquisition, and an analysis and trace of the effects of the observed Pioneer VI gas leak on the orbit. R.N.A.

**N67-14433*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**PIONEER VI HIGH-FREQUENCY DATA ANALYSIS**
R. Motsch, D. Chaney, and D. W. Curkendall *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 57–59 (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

A sinusoidal periodicity discovered in the Pioneer VI doppler tracking data is analyzed. The periodicity is found to arise from a slight offset of the spacecraft antenna from the axis of rotation. This phenomenon is used to make a very accurate determination of the spacecraft rotation rate and to determine the magnitude of the offset itself. R.N.A.

**N67-14434*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**PIONEER B TRAJECTORY DISPERSIONS AND DSN INITIAL ACQUISITION**
J. F. Gallagher *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 59–62 (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

An analysis is presented which relates Pioneer B injection dispersions due to launch vehicle guidance errors to the initial tracking station's acquisition. Two of the parameters most critical to early acquisitions are selected, and upper bounds on the variations of these parameters with injection errors are computed. R.N.A.

**N67-14436*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**WIDE BAND RECEIVER SYSTEM FREQUENCY DIVIDER**
K. Schreder *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 69–71 ref (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

The wide band receiver system is currently in the module checkout phase with less than 30% of the modules remaining to be checked. One of the modules is a frequency divider from 66 MHz. The module's circuit is described, its performance characteristics are discussed, and a schematic diagram of its circuitry is shown. R.N.A.

**N67-14437*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**EPHEMERIS CONTROLLED OSCILLATORS: MODIFICATION OF MOD V PROGRAMMED OSCILLATOR**
G. Thompson *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 71–72 ref (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

A modification to increase the reliability of the Mod V programmed oscillator at the Mars Deep Space Station is briefly described. As a result, the Mod V programmed oscillator gain constant $K_0$ is no longer unity when used in a closed loop phase locked receiver system. The modification was made because of problems encountered in substituting the voltage controlled oscillator (VCO) in the 100 kHz decade. The modification requires a 24-MHz VCO operating at 100 mv rms into 50Ω. R.N.A.

**N67-14438*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**INFORMATION SYSTEMS: ERROR CORRECTION FOR HIGH-SPEED DATA TRANSMISSION**
E. C. Posner and G. Solomon *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 72-74 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

This report describes a coding–decoding scheme suitable for use with Mariner 1964, 1967, and 1969 spacecraft data transmitted over a high-speed data line. The method uses a (15,7) double error-correcting code and a very simple majority logic decoding. The probability of failing to decode correctly is reduced by a factor of more than 200. Author

**N67-14439*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**INFORMATION SYSTEMS: ERROR DETECTION EQUIPMENT**
G. Solomon *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 74–76 ref (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

A modification to the NASCOM error detection equipment for error correction is suggested. The modification will provide for greater and more efficient use of the coding system. Descriptions of the error correction procedures and coding program are presented. R.N.A.

**N67-14443*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**IMPROVED RF CALIBRATION TECHNIQUES: NOISE TEMPERATURE CALIBRATIONS**
T. Y. Otoshi and C. T. Stelzried *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 82–86 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

The results of noise temperature calibrations of the Venus Deep Space Station rf cone antenna are presented. The noise temperature measurements were performed by the Y-factor method, which involves the use of two thermal reference noise standards and switching between the unknown and the thermal noise standards. For the cone calibrations, the two thermal standards used were a cryogenically cooled waveguide termination and an ambient waveguide termination. Results of antenna noise temperature calibrations made at 2388 Mc for the antenna in the circular polarization mode are plotted. Also shown are plots of the 2388 Mc line-loss temperature contribution, receiver temperature, and gas tube temperatures. Overall average noise temperatures for the cone at 2388 Mc are tabulated. R.N.A.

**N67-14444*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**RF TECHNIQUES: EVALUATION OF RADOME MATERIALS FOR THE ASCENSION ISLAND DSS ANTENNA**
R. Seidel and C. Stelzried *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 86–89 *ref* (See N67-14421 05-07) CFSTI: HC$4.25/MF$1.50

The radio frequency characteristics of several radome materials were evaluated using radiometric measurements. Computer methods were used for the evaluation and error analysis data handling. Some of the samples were unaltered, some had seams, and some were soaked in brine several days before measurement. Pertinent results are tabulated. Because the experiment time did not allow for repeatability data on the various samples, in some cases the tolerances on the results are of the same order of magnitude as the results themselves. R.N.A.

**N67-14445*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**EFFICIENT ANTENNA SYSTEMS: APERTURE BLOCKAGE AND SURFACE TOLERANCE LOSS CALCULATIONS FOR NON-UNIFORM ILLUMINATION AND ERROR DISTRIBUTION**
A. Ludwig *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 89–90 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF$1.50

In an antenna with a reasonably well defined aperture is divided into several segments, the efficiency of the whole antenna is related to the efficiency of each segment by .

$$\eta = \left[\sum_{n=1}^{N} (a_n P_n \eta_n)^{1/2}\right]^2$$

where $\eta$ = overall efficiency, $\eta_n$ = efficiency of the nth segment, N = number of segments, $P_n$ = fraction of total radiated power intercepted by the nth segment, and $a_n$ = fractional aperture area in the nth segment. The equation expresses the summation of the field contributions of each segment, assuming that the contributions from all segments are in phase and normalized by total area and total radiated power. For overall efficiency, spillover is accounted for by the fact that the sum of $P_n$ is in general less than 1. The equation is extended for the case of phase differences in the contributions of individual segments. The two applications considered are in evaluating aperture blockage loss, and in determining surface tolerance loss. R.N.A.

**N67-14446*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**EFFICIENT ANTENNA SYSTEMS: FREQUENCY AND SIZE DEPENDENCE OF A SUBREFLECTOR BEAMSHAPING FLANGE**
A. Ludwig *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 90–96 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

The subreflectors for the 85-ft and 210-ft-D DSIF antennas have flanges designed for S-band operation. To evaluate the subreflectors' performance at several frequencies, subreflector configurations and illumination were input to a computer program which calculates scattering from an arbitrary surface of revolution. The computed scattered patterns were then input to another program which evaluates antenna efficiency. Several computed scattered patterns are given which show that operating above the design frequency causes distortion at the pattern edges. The resulting antenna efficiencies for the illumination patterns show that the flange improves performance at the design frequency, and has little effect on efficiency at higher frequencies. However, subreflectors without flanges are smaller than optimum, and their efficiencies would be 1 to 2% higher if the hyperboloids were larger. The smaller subreflector flange subtends a larger portion of the feed pattern, resulting in 3% less forward spillover which more than makes up for its larger diffraction effects. For the hyperboloid/flange combination, smaller subreflectors are better than larger subreflectors. R.N.A.

**N67-14447*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**ADVANCED DEVELOPMENT OF MICROWAVE ANTENNA SUBSYSTEMS: 100-KW SCM CONE TESTS**
R. W. Hartop *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 96–98 *ref* (See N67-14421 05-07) CFSTI: HC$4.25/MF$1.50

The results of tests made on a complete Goldstone Duplicate Standard S-band Cassegrain monopulse cone assembly at power levels up to 100 kw CW are briefly discussed. The tests were performed at the Venus Deep Space Station using an available 100 kw klystron. Despite some difficulty with harmonic power, the cone tests were highly successful and indicate that the design goal of 2000 kw CW microwave components may be achieved soon. R.N.A.

**N67-14448*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**STEP RECOVERY DIODE MULTIPLIER**
E. R. Caro *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 99–101 (See N67-14421 05-07) CFSTI: HC $4.25/MF$1.50

A frequency multiplier was developed for use in the planned Block IIIC modification of the DSIF tracking system local oscillator and transmitter exciter multiplier chains. The multiplier consists of a step-recovery diode mounted in a two cavity output bandpass filter. The diode is series fed through a low pass filter which isolates the input network from the output network. The performance and test results of the multiplier are summarized. A photograph and schematic diagram of the multiplier are included. R.N.A.

**N67-14449*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**MSFN TRANSMITTERS**
R. I. Lau *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 101 (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

The implementation and testing of the DSN/MSFN dual transmitter located at the Pioneer Station are briefly reviewed. R.N.A.

**N67-14451*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**ADVANCED TRANSMITTER DEVELOPMENT**
R. E. Arnold *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 103–107 *ref* (See N67-14421 05-07) CFSTI: HC$4.25/MF$1.50

During this reporting period, tests were conducted on the 1-MW high-voltage power supply at the Goldstone Venus Station, and a linear exciter was implemented and tested for amplitude-modulating the Mariner 100-kW transmitters. This report summarizes the results of the tests. Author

**N67-14452*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**S-BAND PLANETARY RADAR RECEIVER DEVELOPMENT**
C. F. Foster *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 107–110 refs (See N67-14421 05-07) CFSTI: HC$4.25/MF$1.50

During this reporting period, the construction and installation of the 2388-MHz bistatic radar receiver was completed. This receiver will be used for the Mercury and Venus planetary radar experiments. Author

**N67-14453*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**RESISTIVE LOOP DIRECTIONAL COUPLER CALIBRATION**
R. C. Chernoff *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 110–114 refs (See N67-14421 05-07) CFSTI: HC$4.25/MF$1.50

The resistive loop type directional coupler presently used as a reflected power monitor on high-power transmitters was calibrated by two different methods. The results agree to within experimental error. The frequency variation of directivity was also measured and was found to be small (1.5%) but adequate for the application. Author

**N67-14632*#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**STATISTICAL COMMUNICATION THEORY**
A. G. Bose, A. V. Oppenheim, D. E. Nelsen, J. D. Bruce, and R. F. Bauer *In its* Res. Lab. of Electron. 15 Oct. 1966 p 95–104 refs (See N67-14621 05-34) CFSTI: HC$6.00/MF$1.25 (Contract DA-36-039-AMC-03200(E); Grant NSF GK-835)

Presented in the first part of this work is a new approach to binary signal detection, i.e., the problem of deciding after reception which of two possible signals has been transmitted over a noisy channel. Considered is the message signal s(t) which takes on values $s_1$ and $s_2$ with probabilities q and (1-q), respectively. For convenience it is assumed that $s_1 < s_2$-s(t) is contaminated by an additive, independent noise signal n(t). This results in a received signal x(t)=s(t)+n(t). The problem is mathematically formulated by optimum quantization and error-weighting function. The results are compared with those obtained by traditional detection theory approaches. In the second part of the work, noise in magnetic recording systems caused by the recording tape was studied. Derived was a power density spectrum for the noise flux in the reproduce head in terms of a model incorporating all possible random properties of the tape, which would account for the experimentally observed increase in the noise with uniform tape magnetization. Experimental verification of the model made it possible to determine the cause of the noise. K.W.

**N67-14664#** Beckman Instruments G.m.b.H., Munich (West Germany).
**PCM BIT DETECTORS WITH CORRECTED ERROR-PROBABILITY [PCM BIT DETEKTOREN MIT VERBESSERTER FEHLER-WAHRSCHEINLICHKEIT]**
F. Neumayer *In* WGLR Session Rept. of the WGLR-Subcomm. on Aerodyn. Measuring Tech. 31 May 1966 p 49–63 refs (See N67-14661 05-08) CFSTI: HC$6.00/MF$1.25

Described is a space telemetry system that uses pulse-code modulated bit detectors to correct noise signals in data links between space vehicles and Earth. The system incorporates the difference-integrating detectors for split-phase coding and increases its output by detection of bit-pairs and suppression of drift errors. Its bit-error capacity of $10^{-6}$ increased the signal-to-noise ratio by 3 db and improved the overall error probability by a factor of 1000. Transl. by G.G.

**N67-14665#** Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany).
**THE MULTIPLEXER TECHNIQUE FOR MULTIPLE DATA TRANSFER IN SINGLE TRANSMISSION CHANNEL [DIE MULTIPLEXTECHNIK ZUR UEBERTRAGUNG MEHRERER MESSWERTE UEBER EINEN UEBERTRAGUNGSKANAL]**
H. Bothe *In* WGLR Session Rept. of the WGLR-Subcomm. on Aerodyn. Measuring Tech. 31 May 1966 p 65–81 refs (See N67-14661 05-08) CFSTI: HC$6.00/MF$1.25

Described is a semi-automatic data processing system that evaluates multiple measurement data obtained onboard flying vehicles. A time multiplexer technique is used to transfer the data to earth via a single transmission channel where they are decoded and converted by digital computer. Some sample conversions of telemetered pressure, velocity, and temperature measurements are included. Transl. by G.G.

**N67-14666#** Bölkow Entwicklungen K. G., Munich (West Germany).
**AUTOMATIC COLLECTION OF DATA CONVERTER CALIBRATION POINTS BY PRESSURE IMPULSE PICK-OFF [AUTOMATISCHE ERFASSUNG DER EICHPUNKTE VON MESSWERTWANDLERN MIT HILFE EINES DRUCKIMPULSGEBERS]**
E. Binder *In* WGLR Session Rept. of the WGLR-Subcomm. on Aerodyn. Measuring Tech. 31 May 1966 p 83–104 (See N67-14661 05-08) CFSTI: HC$6.00/MF$1.25

This automatic pressure impulse transmitter with logic printout is able to evaluate measurements from several calibration points at the same time. Its digital logic directs the electric impulses and registers only desired data-pairs. Transl. by G.G.

**N67-14789*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**STERILIZABLE COMMUNICATIONS AND DATA-HANDLING SYSTEMS**
Wayne E. Arens *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 393–431 (See N67-14761 05-05) GPO: HC$2.25; CFSTI: MF$2.50

Sterilization program efforts associated with the spacecraft telecommunications system were conducted on pressure transducers, magnetic tape recorders, and magnetic core memories. Available pressure transducers were investigated and those potentially capable of withstanding sterilization were selected. These were subjected to sterilization testing and test results were analyzed to define any problems resulting from the sterilization environment. A program was undertaken to define and solve problems associated with the sterilization of a spacecraft magnetic tape recorder. Each component was designed or developed for sterilization compatibility and exposed to sterilization tests. After component qualification, a complete transport was assembled, subjected to sterilization testing, and life tested. A magnetic core memory subsystem was defined and a program conducted to solve sterilization problems. All memory components were evaluated and qualified for sterilization compatibility. R.N.A.

**N67-14866#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**PROPAGATION MECHANISM OF RADIO WAVES RADIATED BY AN ARTIFICIAL EARTH SATELLITE**
A. N. Kazantsev and D. S. Lukin *In its* Cosmic Res. 4 Aug. 1966 p 89–91 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF$1.50

The propagation mechaniam of radio waves emitted by an ISZ [Artificial Earth Satellite] is examined (without consideration of the magnetic field or collisions) on the basis of the calculated trajectories of radio waves in an inhomogeneous ionosphere whose electron concentration varies arbitrarily in two coordinates. The Fermat principle is used as a basis for derivation of a system of first-order differential equations by numerical solution of which we can calculate the trajectories of the rays and the propagation time of the radio signal. Author

**N67-14867#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INTENSITY OF THE FIELD OF SHORT RADIO WAVES EMITTED BY AN ARTIFICIAL SATELLITE OF THE EARTH**
A. N. Kazantsev and D. S. Lukin *In its* Cosmic Res. 4 Aug. 1966 p 92–99 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF$1.50

Considered is the intensity of the field of short radio waves emitted by an artificial satellite of the earth as a function of distance. We find the focusing factor for the emission of an artificial satellite of the earth and the integral coefficient absorption along the trajectory of the ray. The intensity of the field for various parameters of the ionosphere with consideration of focusing and integral absorption have been calculated. A conclusion is drawn on the basis of these calculations that in the case of reflection exclusively from the ionosphere, the intensity of the field does not diminish in inverse proportion to distance, but considerably more slowly. Author

N67-14903*# Avco Corp., Wilmington, Mass. Missiles, Space and Electronics Group.
**A STUDY OF ABLATION EFFECTS ON ANTENNA PERFORMANCE Final Report, 7 Jul. 1965–12 Oct. 1966**
Ronald L. Fante, John R. McLaughlin, and John E. Trousdale 12 Oct. 1966 240 p refs
(Contract NAS9-4916)
(NASA-CR-65561; AVSSD-0277-66-RR) CFSTI: HC $3.00/MF $2.60 CSCL 09F

Artificial dielectrics were developed to electrically simulate the Apollo command module heat shield, Avcoat 5026-39. The simulators were developed for hot and cold conditions of the heat shield so that its effect on antenna performance could be measured at room temperature. For scaled measurements, third-scale and fifth-scale simulators were fabricated. Complex permittivity of Avcoat 5026-39 was measured from 4°K to 2000°K to characterize its electrical properties for simulator development. Simulator performance was checked by comparing radiation patterns of antennas covered with full-, 1/3-, and 1/5-scale simulators to those covered with Avcoat 5026-39. A computer program to calculate the radiation patterns and impedance of an open-ended-waveguide antenna covered with a dielectric on a flat ground plane is given. Author

N67-14912*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**TELEMETRY DATA PROCESSING PLAN FOR THE OGO-A MISSION**
Michael Mahoney and John J. Quann Sep. 1966 182 p
(NASA-TM-X-55634; X-545-65-350) CFSTI: HC $3.00/MF $1.95 CSCL 09F

Details of the plan are presented. The overall OGO program, the OGO-A mission, and the observatory tracking equipment are described. The multiplexing and transmission of experiments and subsystem data in the OGO-A spacecraft, with emphasis on the multiplexing of data handled by the pulse code modulation (PCM) telemetry, are discussed. The ground data acquisition stations, including procedures, standards, and schedules governing their operations are described. In addition, the OGO-A and PCM analog data processing; the OGO-A data processing on digital computers; the techniques used to process the PCM digital data in each of the four major intermediate programs of the OGO-A plan; and the four major end data programs for PCM data, are described. Also presented are the techniques used to process the above data; the disposition of the data; and the descriptions and locations of experiments and names of experimenters. L.S.

N67-14962# Lincoln Lab., Mass. Inst. of Tech., Lexington.
**HAYSTACK POINTING SYSTEM: RADAR COORDINATE CORRECTION**
Charles A. Clark and Arthur A. Mathiasen, ed. 24 Oct. 1966 31 p refs
(Contract AF 19(628)-5167)
(TN-1966-56; ESD-TR-66-551; AD-641603) CFSTI: HC $2.00/MF $0.50

In the Haystack Pointing system, errors caused by atmospheric refraction, gravitational deformation of the antenna, skewed axes and resolver error are compensated for by a correction program in the computer which adds the necessary biases to the geometric values of azimuth and elevation to produce an effectively correct aiming of the antenna. Author (TAB)

N67-15035# Brown (D.) Associates, Inc., Eau Gallie, Fla.
**ADVANCED TECHNIQUES FOR THE REDUCTION OF GEODETIC SECOR OBSERVATIONS Final Report**
Duane C. Brown 29 Jul. 1966 105 p refs
(Contract DA-44-009-AMC-937(X))
(AD-640238) CFSTI: HC $4.00/MF $0.75

Techniques developed earlier (see AD-425 480) for the self-calibration of tracking systems are applied to geodetic SECOR system. An error model for Geodetic SECOR is developed, special attention being devoted to inospheric refraction. The rigorous adjustment of SECOR observations with error-model recovery is developed first on a strictly geometric basis for the isolated quad (quadrilateral). This development is extended to a special multi-quad net restricting parametric recovery to trajectory coordinates and station coordinates. It is then further extended to a general multi-quad net considering also the recovery of unstable error coefficients reinitialized for each orbital pass over each station. The adjustment is then reformulated to exercise short-arc orbital constraints, first for an unlimited number of passes over an isolated quad and subsequently for a net comprising an unlimited number of interconnected quads (each observing an unlimited number of passes). This adjustment involves the simultaneous recovery of all station coordinates in the net, together with a fresh set of orbital elements and a fresh set of error coefficient for each pass. Results obtained from the application of the theory to data gathered from two test quads establish that the reduction has an impressive potential. Because it also automatically solves the problem of unresolved, constant ranging ambiguities, the new reduction promises a much shorter data reduction cycle than the conventional reduction. Author (TAB)

N67-15063# Ballistic Research Labs., Aberdeen Proving Ground, Md.
**A TECHNIQUE FOR DETERMINING THE EFFECTIVE POWER PATTERNS OF MILLIMETER-WAVE RADIOMETRIC ANTENNAS**
R. B. Patton, Jr. and C. L. Wilson May 1966 68 p refs
(BRL-R-1322; AD-640009) CFSTI: HC $3.00/MF $0.75

The VARR (Variable Range Reflector) Method is a technique which has been developed to measure the effective power patterns of millimeter-wave radiometric antennas. In this method, a large movable metallic surface is oriented to reflect radiation from the zenith into an antenna which is directed along the horizontal. Radiometric temperature is measured as a function of the range of the reflector from the antenna. In addition, the water vapor content of the atmosphere and the radiometric temperatures in the directions of background and zenith are observed. A computing procedure has been devised to determine the complete pattern and gain characteristics of the antenna system purely on the basis of data provided by the measuring system. The method has been used to successfully determine the effective power patterns of a number of antenna systems. These results form the basis of a comparative evaluation of antenna system performance that is in substantial agreement with the observed effectiveness of these same antennas in previous measurements. Author (TAB)

N67-15071# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**TRACKING A SPACESHIP**

8 Apr. 1966 1966 24 p Transl. into ENGLISH from Aero-Sport (E. Germany), no. 9, 1965 p 290–297
(FTD-TT-65-1706; TT-66-62231; AD-638881) CFSTI: HC $1.00/MF $0.50

Discussion of the design and performance of the Russian Vostok spacecraft. TAB

N67-15085# Lincoln Lab., Mass. Inst. of Tech., Lexington.
**HAYSTACK POINTING SYSTEM: DIGITAL EQUIPMENT ORGANIZATION**
Paul D. Smith 10 Oct. 1966 21 p refs
(Contract AF 19(628)-5167)
(ESD-TR-66-452; TN-1966-15; AD-641641) CFSTI: HC $1.00/MF $0.50

The report describes the operation and organization of the digital equipment associated with the Univac 490 pointing computer at Haystack. All of the input/output equipment connected to the U490 is discussed with the major emphasis being placed on that equipment associated with pointing the antenna. Author (TAB)

N67-15098# Naval Postgraduate School, Monterey, Calif.
**APPLICATION OF THE KALMAN FILTER TO SPHERICAL DISCRETE TRACK SMOOTHING AND PREDICTION**
James S. Demetry and Ralph E. Hudson 1 Sep. 1966 23 p
(TR/RP-70; AD-639920) CFSTI: HC $1.00/MF $0.50

The paper investigates the effectiveness of a method for circumventing the problem of nonlinear observation of a linear system's state variables in the Kalman filter discrete estimation scheme. The method employs a linearization of the nonlinear coordinate transformation, in this case cartesian to spherical. The performance of a filter designed by this method is observed as a function of measurement error, accuracy of filter initialization, and the relevance of the estimated initial error covariance, P sub 2/1. The investigation reveals that the most critical factor in filter performance and stability is filter state initialization. Author (TAB)

N67-15108# Michigan Univ., Ann Arbor. Communication Sciences Lab.
**RESEARCH ON SPEECH COMMUNICATION AND AUTOMATIC SPEECH RECOGNITION Final Report, Jan. 15–Jul. 31, 1966**
Gordon E. Peterson and June E. Shoup 15 Aug. 1966 22 p refs
(Grant AF-AFOSR-595-66)
(AFOSR-66-2692; AD-642763) CFSTI: HC $3.00/MF $0.65

The report reviews four major areas of research. The first area is concerned with the theory of phonology which has included the development of physiological and acoustic phonetic theories, and work on a formal theory of phonemics. The second area is concerned with the linguistic interpretation of the speech wave. It is suggested that it is more realistic to attempt to interpret the speech wave types and the acoustical parameters of speech according to sets of phone types rather than directly as phonemes. The third area of investigation is concerned with the phonological description of languages, particularly midwestern American English. Such a description includes a statement of the phonemes and their associated allophones, a statement of the phone type environments of the various allophones, and a statement of the allowable phoneme sequences. The forth area of investigation concerns lexical procedures in automatic speech recognition. The report includes summaries of recent publications under the grant and a bibliography of articles and reports which have been published by the Communication Sciences Laboratory under the sponsorship of the Directorate of Information Sciences. Author (TAB)

N67-15114# Lincoln Lab., Mass. Inst. of Tech., Lexington.
**MAXIMUM LIKELIHOOD TRAJECTORY DETERMINATION FROM RADAR DATA**
Alvin R. Warwas and Shou-Chin Wang 27 Oct. 1966 38 p refs
(Contract AF 19(628)-5167; ARPA Order 600; Proj. Defender)
(ESD-TR-66-554; TN-1966-49; AD-642334) CFSTI: HC $3.00/MF $0.65

Analysis is given for accurately determining a target's trajectory from radar data using maximum likelihood techniques. The method is incorporated in a computational program and obtains converged trajectories in 1 to 3 iterations when applied to satellite track data from the Tradex radar. Several tracks with differing signal-to-noise ratios are presented. The average rms residuals obtained for 300 to 450 seconds of data are 25 feet in range and 0.05 degrees in elevation and azimuth, while some tracks at high s/n resulted in angle residuals of about .01 degrees, equal to the pointing accuracy of Tradex. Author (TAB)

N67-15220*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**THE FEASIBILITY OF A DIRECT RELAY OF APOLLO SPACECRAFT DATA VIA A COMMUNICATION SATELLITE**
Paul E. Schmid 1 Sep. 1966 73 p refs
(NASA-TM-X-55627; X-507-66-310) CFSTI: HC $3.00 / MF $1.30
CSCL 09F

The extent to which communication satellites can be utilized in the 1970's for relaying data directly from an Apollo-type spacecraft to a fixed earth station estimated. Both 24-hour synchronous altitude (36,000 km above the earth's surface) and 6-hour orbits (10,400 km above the earth's surface) for the communication satellite are considered. A unified S-band type of data transfer is assumed. The relative merit of using frequencies below S-band for voice communication is also briefly discussed. Author

N67-15248# Naval Research Lab., Washington, D. C.
**ELECTROMAGNETIC WAVE INTERACTION WITH ROCKET EXHAUSTS**
W. W. Balwanz *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 699–729 refs (See N67-15234 05-25) CFSTI: HC $7.00/MF $1.75

The nature of the interactions between electromagnetic waves and an exhaust plasma is established. The path through an underdense plasma may be determined by use of a ray-tracing technique and the absorption along the path obtained by graphical integration. The path for waves bent or ducted around an overdense plasma, passing near or through the transition region between the overdense and the underdense regions is not readily established. When the path can be established, the calculation of the signal loss is obtained by graphical integration. Author

N67-15268# Virginia Univ., Charlottesville. Industrial Research and Development Center.
**INVESTIGATION OF THE POWER SPECTRUM PRODUCED BY THE LINEAR MIXING OF FREQUENCY MODULATED SIGNALS Final Report**
G. A. McAlpine, J. C. Isaacs, and C. M. Weant Sep. 1966 159 p refs
(Contract DA-49-186-AMC-315(D))
(IRDC-3358-111-66U; AD-639707) CFSTI: HC $5.00/MF $1.00

A generalized approach to the spectrum analysis of randomly frequency modulated signals is presented and indicates the need for approximate methods and knowledge of their expected accuracy. Sufficient conditions are established for the applicability of Woodward's (adiabatic) Theorem for large modulation index fm

spectra and an upper bound is given for the spectral error committed in using the approximation for sinusoidal and/or Gaussian random modulation. The approximate spectra are compared with computed spectra for ideal low pass, ideal band pass and sinusoidal plus ideal band pass Gaussian modulation. The computer programs employed are described. Also given is a development of an approximate expression for the spectra of a sinusoid with random phase switching which is compared to results obtained by making some simplifying assumptions and employing an equation given in Lawson and Uhlenbeck, M.I.T. Radiation Laboratories Series, Vol. 24, pg. 45. Author (TAB)

**N67-15282#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**SECTOR DISPLAY SCOPE USING A FLAT CATHODE-RAY TUBE**

V. N. Vetlinskiy 18 Apr. 1966 7 p Transl. into ENGLISH from Russian Patent No. 156191 (Appl. no. 794751/26-9, 14 Sep. 1962) 2 p

(FTD-TT-65-997; AD-640324) CFSTI: HC $1.00/MF $0.50

The object of the invention is a sector display scope (indicator of sector survey) using a flat cathode-ray tube with a device for obtaining distance scanning. To increase the speed of the scanning and improve the resolving capacity of the indicator an electromagnetic retardation line is used the lead-outs of which are connected up to metallic bands on the surface of a flat cathode-ray tube. Author (TAB)

**N67-15314#** Michigan Univ., Ann Arbor. Communication Sciences Lab.

**STUDIES IN SPEECH ANALYSIS AND SYNTHESIS Final Report**

Gordon E. Peterson Aug. 1966 51 p refs

(Contract Nonr-1224(22))

(AD-640406) CFSTI: HC $3.00/MF $0.50

The report contains summaries of the journal articles and technical reports which have been published on a project with the Information Systems Branch of the Office of Naval Research on speech analysis and synthesis. Several of the investigations have included both theoretical and experimental studies. The subjects of investigation have included: techniques of spectrographic analysis, the recording and reproduction of speech signals with ferroelectric tapes, the automatic analysis of the information-bearing acoustical parameters of speech, the effects of certain of the acoustical parameters of speech on linguistic judgments, linguistic considerations in the measurement of speech intelligibility, aural processing of the speech wave, and techniques of speech synthesis. After a short introduction, the report presents a brief summary of each article and technical report published during the course of the research project. Author (TAB)

**N67-15324#** Air Force Cambridge Research Labs., Bedford, Mass. Microwave Physics Lab.

**REVIEW OF THE EARTH MODE COMMUNICATION PROGRAM AT AFCRL**

Leon A. Ames, John W. Frazier, and Arnold S. Orange (Geoscience, Inc.) Jul. 1966 19 p refs Presented at 12th AGARD Symp., Paris, Apr. 1966 *Its* Spec. Rept.-48

(AFCRL-66-481; AD-640319) CFSTI: HC $1.00/MF $0.50

The program in earth mode communications research at the U. S. Air Force Cambridge Research Laboratories is reviewed. Emphasis is placed on geological and geophysical problems encountered in the course of the program. Communications modes studied include: (1) 'deep-strata', wherein radio frequency electromagnetic waves are propagated between buried antennas over a path entirely within rock strata, and (2) 'conduction current', consisting of ULF conduction field communications between long, grounded dipoles. Deep-strata studies were carried out utilizing both loops and linear antennas immersed in the rock medium. Antenna and transmission path characteristics were studied under a variety of conditions and over paths up to 4.5 km in length. It was found that two of the greatest problems facing the communicator are the complexity of the earth's crust and its low values of electrical resistivity. Therefore, a geological and geophysical study was performed to evaluate possible transmission sites in the United States. Conduction field studies were performed using what was essentially the dipole-dipole geophysical resistivity sounding technique. Field tests were made at frequencies from 0.01 Hz to 10 Hz and at ranges to 32 km. Author (TAB)

**N67-15328#** Syracuse Univ. Research Corp., N. Y. Defense Systems Lab.

**[DESIGN AND DEVELOPMENT OF MODULAR MONITOR SYSTEMS TO PROVIDE FOR RAPID PROCESSING OF COMMUNICATION SIGNALS] Semiannual Progress Report, 1 Jan.–30 Jun. 1966**

Gordon H. La Tourette 15 Jul. 1966 21 p

(Contract Nonr-4858(00))

(DSL-R-148; AD-640455) CFSTI: HC $1.00/MF $0.50

A number of operational improvements were made in the equipment containers used in the Modular Kit systems. The entire microwave receiver/display equipment (including all modifications recommended by DSL) used in the Modular Kit systems has been designated the Polarad Model TB-A. Two AN/URR-52A Panoramic Data Receiving Sets were received and are being checked out prior to installation in the Modular Kit systems. Further improvements have been made in the Birdie Oscillator circuitry used in the Frequency Demultiplexers for the Modular Kit systems. TAB

**N67-15337#** Rome Air Development Center, Griffis AFB, N. Y.

**ULTRA WIDEBAND DIGITAL DELAY LINE Final Report**

John B. Payne, III Sep. 1966 72 p refs

(RADC-TR-66-123; AD-641370) CFSTI: HC $3.00/MF $0.75

The report presents the detailed technical analysis, experimental results, and problems encountered in the design and construction of a four-bit digital delay line having an instantaneous, nondispersive, and lossless bandwidth of 400 mc/s. The frequency range covered was from 50 to 450 mc/s. The signal was switched either through or around the different time delay elements. The switches consisted of wideband amplifiers which minimize amplitude and phase fluctuations across the band and between the different signal paths. Switching was performed by purely electronic means with switching time less than 50 nanoseconds. Amplitude variations up to 400 mc/s were less than 1 db with a phase error of 2 degrees. At 450 mc/s the errors were 3 db and 10 degrees, respectively. Also covered is the use of such a device for i-f time delay steering of wideband array antennas. Problems encountered in properly terminating wideband delay lines and component selection and layout are discussed. Author (TAB)

## 08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

**N67-14384#** Joint Publications Research Service, Washington, D. C.

**EVALUATION OF THE OUTPUT CAPACITY OF A COMPUTATION SYSTEM MADE UP OF ORDINARY COMPUTERS**

D. A. Pospelov *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 139–160 refs (See N67-14341 05-10)

A method is investigated for evaluating the output capacity of a system of computers operating in parallel solving a common problem. The evaluation is based on the structure of the system and the structure of the algorithms realized in the system. On the basis of a comparison, the optimal relationship of these structures is indicated. Author

N67-14440*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**DIGITAL DEVICES DEVELOPMENT: NINE-CHANNEL AUTOCORRELATOR AND SDS 900 SERIES COMPUTER INTERFACE LOGIC**
E. B. Lutz *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 76–78 *ref* (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

The logic used in interfacing the nine-channel autocorrelator and the SDS 930 computer at the Venus Deep Space Station is described. The interfacing optimizes the efficiency of the computer in controlling external devices. An illustration of the basic setup is given which shows a 30-ft cable connecting the autocorrelator with the computer through POT and PIN cards which contain the interface logic. These "J-Cards" are standard ZX-11 blank cable plugs modified to contain integrated circuit logic. In controlling peripheral units, the computer transmits a 24-bit word in parallel, of which a certain number of bits are decoded to determine which of the external devices is to be selected. Other bits are decoded and used to generate specific functions inside the unit being selected. These commands are generated by the computer and transmitted through the POT card while data from the external devices enter the computer through the PIN card. Initial tests were performed on the cable plus interface cards on an SDS 930 computer, simulating the various logical conditions. Final tests at the Venus Deep Space Station were satisfactory, and the logic is currently installed and operative. R.N.A.

N67-14634*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**COGNITIVE INFORMATION PROCESSING**
O. J. Tretiak, H. P. Hartman, J. A. Newell, S. D. Shoap, J. A. Williams et al *In its* Res. Lab. of Electron. 15 Oct. 1966 p 129–158 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25
(Contract DA-36-039-AMC-03200(E); Grants NSF GK-835; NIH G-MH-04737-06)

Picture processing is treated in the following articles: (1) a description of a transducer device for communicating between computers and pictures which can accept transparencies, measure the transmission at various points on the transparency, convert this to a digital number, and produce pictures from digital data; (2) a summary of a thesis on error effects and quality of picture transmission by PCM over a noisy channel; (3) description and theory of a differential PCM digital communication system that transmits a quantized representation of the difference between a signal sample and its predicted value; and (4) a brief discussion of variable-velocity delta modulation, a new digital picture coding scheme with a scan rate that is not constant. Two articles concerning sensory aids contain the following: (1) a summary of a thesis on a word-at-a-time tactile display device that permits simultaneous presentation of a maximum of 8 Braille-like cells to the fingers of both hands; and (2) a storage-saving method for converting the output of reading machines into magnetic tape information, which in turn can be converted to Braille. K.W.

N67-14661# Wissenschaftliche Gesellschaft fur Luft- und Raumfahrt, Cologne (West Germany).
**SESSION REPORT OF THE WGLR-SUBCOMMITTEE ON AERODYNAMIC MEASURING TECHNIQUES [BERICHT UEBER DIE SITZUNG DES WGLR-UNTERAUSSCHUSSES AERODYNAMISCHE MESSTECHNIK]**
31 May 1966 208 p refs In GERMAN Conf. held at Munich, 12 Mar. 1966
(DLR-Mitt.-66-04) CFSTI: HC $6.00/MF $1.25

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9. USE OF DIGITAL MEASURING TECHNIQUE IN TRANSMISSION RESEARCH F. von Burger-Scheidlin (Deutsche Forschungsanstalt fur Luft- und Raumfahrt) p 163–175 ref (See N67-14670 05-08)

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12. DATA PREPARATION AND PROCESSING OF ANALOG MEASUREMENTS FROM FREE FLIGHT EXPERIMENTATION E. Ahlborn (Bolkon Entwicklungen K. G.) p 201–213 (See N67-14673 05-08)

N67-14662# Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany).
**COMPARISON BETWEEN ANALOGUE AND DIGITAL MEASURING METHODS [VERGLEICH ANALOGER UND DIGITALER MESSVERFAHREN]**
A. Becker *In* WGLR Session Rept. of the WGLR-Subcomm. on Aerodyn. Measuring Tech. 31 May 1966 p 7–32 refs (See N67-14661 05-08) CFSTI: HC $6.00/MF $1.25

Analog and digital measuring techniques are compared for their individual characteristics and applications. Signal quantization in digital systems eliminates perturbation noise; even in long transmission chains, in which the overall noise level is more than one half of the quantization step, multiple regeneration processes

reduce the noise to the quantization level. Mathematical evaluation proves that the binary digital computation is more resistant to errors introduced by outside as well as inside random noises, but requires a wider bandwidth than a quantized analog signal. Transl. by G.G.

**N67-14663#** Electronic Associates G.m.b.H., Aachen (West Germany).

**DATA PROCESSING ELEMENTS IN INTERPOLATION TECHNIQUE FOR DATA CAPACITY, DATA PROCESSING, AND DATA RECORDING [DATENVERARBEITUNGSELEMENTE IN EINSCHUBTECHNIK FUER MESSWERTERFASSUNG, MESSWERTVERARBEITUNG UND MESS-REGISTRIERUNG]**

N. Chismon *In* WGLR Session Rept. of the WGLR-Subcomm. on Aerodyn. Measuring Tech. 31 May 1966 p 33–48 (See N67-14661 05-08) CFSTI: HC $6.00/MF $1.25

Plug-in techniques for measurement data storage, data evaluation, and data registration are described and specifications for basic plug-in units in multiple data processing computers are presented. Concepts of programming interfaces for ten plug-in units are developed and some examples for analog-to-digital converters of 2-bit, 8-bit, 12-bit impulses, memory buffers, and 4-bit binary counters are given. Transl. by G.G.

**N67-14667#** Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

**STATISTICAL DATA PROCESSING ENCOMPASSING THE DO 31 TEST PROGRAM [STATISTISCHE MESSWERTVERARBEITUNG IM RAHMEN DES DO 31-VERSUCHSPROGRAMMES]**

C. Miller and G. Schweizer *In* WGRL Session Rept. of the WGLR-Subcomm. on Aerodyn. Measuring Tech. 31 May 1966 p 105–137 refs (See N67-14661 05-08) CFSTI: HC $6.00/MF $1.25

Discussed is the statistical measurement evaluation computer system for the experimental Do 31 aircraft that determines digital the correlation functions and performance characteristics from flight test data. Statistical evaluation of more than 100 flight tests through automatic digital data processing made it possible to shorten measurement times and measurement intervals and resulted in improved accuracy. It was found that most data covering the hovering phase of the aircraft are of stochastic nature and possess a Gaussian amplitude distribution. Transl. by G.G.

**N67-14668#** Beckman Instruments G.m.b.H., Munich (West Germany).

**RAPID DATA COLLECTION SYSTEM WITH MAGNOSTRICTIVE DELAY CIRCUITS AS INTERMEDIATE MEMORY [SCHNELLES DATENENERFASSUNGSSYSTEM MIT MAGNETO-STRIKTIVEN VERZOEGERUNGSLEITUNGEN ALS ZWISCHEN-SPEICHER]**

F. Neumayer *In* WGRL Session Rept. of the WGLR-Subcomm. on Aerodyn. Measuring Tech. 31 May 1966 p 139–145 refs (See N67-14661 05-08) CFSTI: HC $6.00/MF $1.25

Described are analog to digital converters able to process 250,000 impulses into a 10-bit binary word during one second. Their high speed conversion velocity requires the use of delaying circuits as buffer memories that collect the impulses until further processing at the proper time. The following systems are described in detail: (1) multiple oscilloscopes with photographic registration or galvanic cells with light response oscillators; (2) analog registration on magnetic band with playback and analog-to-digital conversion at reduced tape velocity; (3) analog pulse time conversion; (5) systems with an analog memory for each measuring point; and (8) systems with delay circuits as intermediate memories. Transl. by G.G.

**N67-14669#** Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Porz (West Germany).

**DIGITAL DATA PROCESSING APPARATUS FOR A BLOW-DOWN SUPERSONIC CANAL [DIGITALE DATENERFASSUNGSANLAGE FUER EINEN BLOW-DOWN-UEBERSCHALLKANAL]**

A. Heyser and H. Ziobinski *In* WGRL Session Rept. of the WGRL-Subcomm. on Aerodyn. Measuring Tech. 31 May 1966 p 147–162 refs (See N67-14661 05-08) CFSTI: HC $6.00/MF $1.25

Design and performance of a digital test data computer for a blow-down supersonic wind tunnel are discussed. Potentiometer recorders are used as analog sensors, and coupled spatial encoders provide digital measurements of all aerodynamic pressures between 0.01 and 60 at. This system provides rapid processing of measurements on aerodynamic forces, pressures, and temperatures and determines also the specific angle of incidence. Transl. by G.G.

**N67-14670#** Deutschs Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Strahlantriebe.

**USE OF DIGITAL MEASURING TECHNIQUE IN TRANSMISSION RESEARCH [EINSATZ DER DIGITALMESSTECHNIK BEI DER TRIEBWERKSUNTERSUCHUNG]**

F. von Burger-Scheidlin *In* WGRL Session Rept. of the WGRL-Subcomm. on Aerodyn. Measuring Tech. 31 May 1966 p 163–175 ref (See N67-14661 05-08) CFSTI: HC $6.00/MF $1.25

Test stand supervision of turbine engine transmission systems consists of digital measurements on: (1) geometrical dimensions and angles; (2) working data on rotational speed, thrust, and consumption; and (3) thermodynamic properties in the transmission system. Comparison of analog and digital computer processing methods showed that reduced values of rotation, air flow, thrust, incompressible transmission velocity, etc., can be shown by analog computation. Temperature and pressure measurements require amplification and analog-to-digital conversion. It was concluded that analog-to-digital conversion of aerodynamic measurements is preferable for testing in the aircraft industry. Transl. by G.G.

**N67-14671#** Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Porz (West Germany).

**EXPERIENCES WITH AN ANALOG-DIGITAL MEASUREMENT DATA COLLECTING SYSTEM [ERFAHRUNGEN MIT EINER ANALOG-DIGITALEN MESSWERTERFASSUNGSANLAGE]**

B. Dittie *In* WGRL Session Rept. of the WGRL-Subcomm. on Aerodyn. Measuring Tech. 31 May 1966 p 177–185 ref (See N67-14661 05-08) CFSTI: HC $6.00/MF $1.25

Evaluated is the analog-to-digital test data processing system for jet engine flight data that transmits sensor values into digital information through impulse converters. Measurement data are amplified and smoothed automatically; a digital voltmeter and an encoder project the converted data on printout tape. Transl. by G.G.

**N67-14673#** Bolkow Entwicklungen K. G., Munich (West Germany).

**DATA PREPARATION AND DATA TREATMENT OF ANALOGUE DATA FROM FREE FLIGHT EXPERIMENTATION [DATENAUFBEREITUNG UND VERARBEITUNG VON ANALOGEN MESSWERTEN BEI FREIFLUGVERSUCHEN]**

E. Ahlborn *In* WGLR Session Rept. of the WGLR-Subcomm. on Aerodyn. Measuring Tech. 31 May 1966 p 201–213 (See N67-14661 05-08) CFSTI: HC $6.00/MF $1.25

The basic principles of frequency and time multiplexing telemetry techniques are discussed and analog data transmission

requirements during free flight experiments are evaluated. Comparison of their individual advantages and disadvantages proves that both systems complement each other; simultaneous use of both systems is recommended for aerospace telemetry. Transl. by G.G.

N67-14706# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**FOUR STATES OF THE MAGNETIC MEMORY**
A. Galich 18 Apr. 1966 6 p Transl. into ENGLISH from Leningrad. Pravda (Leningrad), 24 Aug. 1964 p 4
(FTD-TT-65-1667; TT-66-62446; AD-640311) CFSTI: HC $1.00/MF $0.50

Is it possible to create an electronic computing machine of such dimensions as the modern ones have, but working twice or three times as fast. It is possible but for this it is necessary to construct a memory device not with two electrically stable states, as in the case of the existing elements, but three or four. Not long ago in the Soviet Union there was created such a two-opening ferrite magnetic element, the 'sager'. It has four stable states. Simultaneously, there is determined a complex of electrical signals, each of which corresponds to one of four symbols and serves for transmitting information from one memory element to another. The sager possesses the advantage that the information is passed from one element of the memory to another only along one channel of communication for one cycle, which assures the maximum rapidity of action. These properties make it possible to use the sager for quarternary computing machines. Research has shown that by simple technical media there can be distinguished in one circuit only four states - absence of current, movement of current in one direction, movement of current in the other direction, and alternate movement of the current in the two directions. The use of other combinations of electrical signals requires either the creation of apparatus with a great number of cycles or the introduction into one channel of communication of complicated logic devices for distinguishing the signals transmitted from one memory element to another. Author (TAB)

N67-14932*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**AN ALGORITHM FOR THE SYNTHESIS OF BINARY SEQUENCE DETECTORS**
Marvin Perlman 15 Dec. 1966 18 p refs
(Contract NAS7-100)
(NASA-CR-80990; JPL-TR-32-1019) CFSTI: HC $3.00/MF $0.65
CSCL 09B

An algorithm is presented for synthesizing a sequential network to detect a given n-place binary sequence within a serialized binary data stream. Sequences are characterized as binary (n, r) ring sequences and the state assignment is determined from the n r-bit subsequences. The results are compared with the implementation of a binary sequence detector made up of an n-1 stage shift register and an n-input decisional element. Author

N67-14974# International Business Machines Corp., Cambridge, Mass. Advanced Space Systems Dept.
**OGO-POGO TELEMETRY DATA PROCESSING PROGRAM Final Report, May 1965-Aug. 1966**
Donald A. Bacon Oct. 1966 72 p
(Contract AT 19(628)-5114)
(AFCRL-66-602; AD-642150) CFSTI: HC $3.00/MF $0.65

The OGO-POGO series of satellites contained instrumentation required to perform a number of experiments by means of collecting various data of scientific value. This report presents a detailed description of the computer program written to decipher and display photon data collected by experiment 20 of the OGO instrument package. Included also are the techniques used for the handling of data from digitalized tapes, the presentation of this data in digital form, and the provision for retrieving spacecraft information for particular areas of interest. This report is programmer oriented with a section containing all items required for operating the program. Author (TAB)

N67-14985# Lincoln Lab., Mass. Inst. of Tech., Lexington.
**GENERAL-PURPOSE I/O CHANNEL AND INTERFACE FOR HAYSTACK 490 COMPUTER**
John E. Gillis, Arthur F. Dockrey and Stephen B. Russell 10 Oct. 1966 28 p ref
(Contract AF 19(628)-5167)
(ESD-TR-66-454; TN-1966-40; AD-641840) CFSTI: HC $2.00/MF $0.50

A general-purpose interface has been constructed for Channel 5 of the Haystack Univac 490 digital computer. Data inputs are from the radiometer and a general-purpose A/D converter while outputs are a display of right ascension, declination, and hour angle, a CRT display and strip chart recorder, and control of the radiometer and other general-purpose functions. Author (TAB)

N67-14986# Northwestern Univ., Evanston, Ill. Information-Processing and Control Systems Lab.
**GENERATION OF AN OUTPUT REGULAR EXPRESSION OF A SEQUENTIAL MACHINE WITH A SPECIFIED INPUT REGULAR EXPRESSION**
S. S. Yau Oct. 1966 13 p refs Reprinted
(Contract N00014-66-C020-A03; Grant AF-AFOSR-98-65)
(TR-66-105; AD-641745) CFSTI: HC $1.00/MF $0.50

It has been shown that the set of output sequences of a sequential machine due to a regular set of input sequences is regular. However, there is no method of generating the regular expression for the output regular set. The purpose of this paper is to present such a technique which is based on constructing the output graph from the state graph of the sequential machine and the input regular expression. Once the output graph is obtained, the regular expression can readily be obtained by using the signal flow graph techniques proposed by Brzozowski and McCluskey. The technique presented in this paper can be applied to both Moore and Mealy machines. Author (TAB)

N67-14987# Stanford Research Inst., Menlo Park, Calif.
**GRAPHICAL-DATA-PROCESSING RESEARCH STUDY AND EXPERIMENTAL INVESTIGATION Quarterly Report, 1 May-31 Jul. 1966**
R. O. Duda and J. H. Munson Aug. 1966 55 p refs
(Contract DA-28-043-AMC-01901(E))
(ECOM-01901-24; Rept.-24; QR-2; AD-641647) CFSTI: HC $3.00/MF $0.50

The report describes work in progress in each of the stages of the analysis of graphical data (specifically, the recognition of hand-printed FORTRAN text). These stages are: data preparation; input of data to the analysis system; preprocessing; classification; and contextual analysis. A preprocessing and classification method adapted from Jon K. Clemens of MIT was programmed and tested on characters from the data base. The best results were obtained for alphabetic characters only: 58% correct, 23% errors, and 19% rejects. The beginnings of work, directed at improving the recognition rate through the use of contextual relations among individually classified characters, are described. A small study showing that the recognition rate by humans of characters without context is on the order of 99%, and that the quantization performed during input to the system reduces this rate only slightly. Author (TAB)

**N67-15020#** System Development Corp., Santa Monica, Calif.
**UTILIZATION OF ON-LINE INTERACTIVE DISPLAYS**
H. Borko 22 Aug. 1966 35 p refs Presented at the 3d Congr. on Inform. System Sci. and Technol., Buck Hill Falls, Pa., 20–23 Nov. 1966
(SP-2575; AD-640652) CFSTI: HC $2.00/MF $0.50

The versatility and advantages of using on-line interactive displays are illustrated by examples from (1) the General Purpose Display System (GPDS), (2) the Pattern Learning Parser (PLP II), and (3) the Bibliographic On-Line Display System (BOLD). Although these systems are designed for different purposes they all utilize displays as communication channels by which the man and the machine are able to engage in a dialog and work together to solve problems. The computer processes data rapidly and displays the results. The information provided in the displays enables the user to steer and control the step-by-step progress of the program. Not only are problems solved more efficiently, but the users are more satisfied by the results achieved. Author (TAB)

**N67-15058#** Lincoln Lab., Mass. Inst. of Tech., Lexington.
**A COMPUTER SIGNAL-PROCESSING APPROACH FOR THE SHAPIRO FOURTH TEST OF THE GENERAL THEORY OF RELATIVITY**
Ernst Gehrels and Leon G. Kraft 2 Sep. 1966 31 p refs
(Contract AF 19(628)-5167)
(ESD-TR-66-431; TN-1966-23; AD-639733) CFSTI: HC $2.00/MF $0.50

I. I. Shapiro has proposed a new test of the general theory of relativity. The test involves the measurement of a discrepancy (of about 30 km0in the measured range of Mercury or Venus as the direct path from the Earth to the Planet passes through the strong gravitational field of the Sun. Such measurements are now made possible by means of modern high-power radars as the Haystack experimental facility. Still the signal-to-noise ratios available at superior conjunction preclude sufficiently accurate range measurements by the ranging techniques used to date in radar astronomy. The primary difficulties arise from the Doppler spreading due to planetary rotation and range spreading due to the radar depth of a rough planet. R. Price suggested using measurements made of the planetary range-doppler profile for comparison in a two-dimensional cross correlation. He showed that such a procedure yields for the power levels available at Haystack, an overall ranging accuracy of better than 1.5 km (9 μsec in round trip travel time), as opposed to a value of y km obtainable with an optimum choice of transmitter pulse length and a matched filter receiver. The Fourier analyses required for obtaining a detailed range-Doppler profile require a tremendous amount of computation time. This report describes a table look-up approach that effects a Four transform without the use of multiplication. A time saving of at least 10:1 is achieved over a straightforward Fourier analysis. It is thus possible to perform the fourier Analysis and other functions such as pulse compression analysis in real time on the computer facilities available on site.
Author (TAB)

**N67-15062#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CONSIDERATION OF INFALLIBILITY ASPECTS WHEN PLANNING BASIC SYSTEMS OF DIGITAL MACHINES**
A. Kojemski and Z. Swiatkowski 6 Apr. 1966 9 p refs Transl. into ENGLISH from Przeglad Elektroniki (Poland), v. 5, no. 5, 1964 p 252–255
(FTD-TT-65-1654; TT-66-62441; AD-640306) CFSTI: HC $1.00/MF $0.50

Treatise on the necessity and method for attaining reliability in the circuits and components of computers. TAB

**N67-15068#** Ballistic Research Labs., Aberdeen Proving Ground, Md. Ballistic Measurements Lab.
**BRLESC FORTRAN II COMPUTER PROGRAMS FOR ANALYTICAL SOLUTIONS OF THE GENERAL PROBLEM OF PHOTOGRAMMETRY**
Lila M. Butler Jul. 1966 149 p refs
(BRL-MR-1769; AD-641386) CFSTI: HC $5.00/MF $1.00

An analytical treatment of the general problem of photogrammetry, using the Schmid method, for the single camera orientation, the single model orientation and the strip triangulation have been programmed in BRLESC Fortran II. Slight modifications have been made in the single camera and single model programs for the computation of individual mean errors of unit weight for plate coordinates and known point coordinates. Input, output, operating instructions and test runs are provided for the various programs. All these Fortran II programs follow the flow diagrams for the Forast programs which are found in the reports mentioned in the abstract of this report. All input data are compatible. TAB

**N67-15117#** RAND Corp., Santa Monica, Calif.
**GENERAL SHIFT-REGISTER SEQUENCE GENERATORS**
I. S. Reed and Rein Turn Nov. 1966 42 p refs
(P-3473; AD-642347) CFSTI: HC $3.00/MF $0.65

The paper examines the theory of design of shirt-register sequence generators capable of creating non-repeating sequences longer than obtained by the classical linear or nonlinear shift-register sequence generators. This capability is achieved by cyclically modifying the effective connections in the feedback loop. A description of the behavior of k-stage shift-register sequence generators in terms of cyclic transformations on the state space x sub k of a generator is introduced and used to analyze the behavior of a model of the general k-stage shift-register sequence generator. The latter is capable of producing sequences of maximal period of M2 to the kth power by cyclic application of m transformations. Various classes of suitable transformations are described, and use of 'cycle graphs' for choosing sets of transformations to generate sequences of desired periods is proposed as a tool for synthesizing logics for the general shift-register sequence generator. Author (TAB)

**N67-15154*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**AOPB SYSTEMS MANUAL PROGRAM DESCRIPTION R 104 MASTER ORBIT TAPE ROUTINE**
Rosemary C. Jones Feb. 1966 229 p refs
(NASA-TM-X-55633; X-542-66-291) CFSTI: HC $3.00/MF $2.60 CSCL 09B

This routine computes inertial, geocentric, and geodetic position data, velocity data, and geomagnetic and real field data for a given satellite. The data is computed as specified intervals from a given start time to a given end time and is written on one or more of the four BCD and binary tapes. Output always includes a BCD Master Orbit Tape (TI), and may optionally include a BCD Refined World Map Tape (TD), and an Orbital Tape Format-3A or a Satellite Position and Real Field Data Tape (TCB). The interval at which Master Orbit Tape and Orbital Tape Format-3A output is computed may be varied with respect to the distance between the satellite and the center of the earth. Author

**N67-15253*#** Lockheed Missiles and Space Co., Huntsville, Ala.
**DESCRIPTION OF A DIGITAL COMPUTER PROGRAM FOR NOZZLE AND PLUME ANALYSIS BY THE METHOD OF CHARACTERISTICS: USERS MANUAL**
H. W. Butler 11 Dec. 1966 163 p Prepared for JPL
(Contracts NAS7-100; JPL-951567)
(NASA-CR-81143; LMSC/HREC-A783573; TM-54/20-108) CFSTI: HC $3.00/MF $2.60 CSCL 09B

A two-dimensional or axisymmetric method of characteristics computer program is described which is applicable to problems involving supersonic flow of an inviscid adiabatic reacting gas in thermal equilibrium. The program was developed because of critical design problems resulting from the effects of rocket exhaust impingement on objects in the plume. The program is a versatile user oriented analytical tool capable of producing all the gas dynamic nozzle or plume data required for an impingement analysis. A solution may be selected for a nozzle only, a plume only, or a combination of nozzle and plume. Included are discussions of the program capabilities and applications, the symbols and notations used, an index of routines, a description and flowcharts of individual subroutines, and an input–output guide. R.N.A.

**N67-15270#** Lincoln Lab., Mass. Inst. of Tech., Lexington.
**ON-LINE GRAPHICAL SPECIFICATION OF COMPUTER PROCEDURES**
William R. Sutherland 23 May 1966 36 p refs
(Contract AF 19(628)-5167)
(ESD-TR-66-211; TR-405; AD-639734) CFSTI: HC $2.00/MF $0.50

A promising area of application for recently developed computer graphics techniques is computer programming. Two important considerations in using an interactive graphics system for drawing programs are (1) the form of a pictorial programming notation and (2) methods for making a computer execute the program once drawn. These topics are discussed in the context of an experimental graphical programming system running on the Lincoln Laboratory TX-2 Computer. This system uses a block notation for programs and can execute the drawn program with an interpreter. Improved graphical input languages for drawing programs and program notations which combine appropriate features of pictorial and written languages are needed before applications in this area are practical. The benefits to be expected from a graphical approach to programming include (1) automatic documentation, (2) debugging assistance, and (3) natural expression of parallel processes. Author (TAB)

**N67-15300*#** Analytical Mechanics Associates, Inc., Uniondale, N. Y.
**MODIFICATIONS OF THE GODDARD MINIMUM VARIANCE PROGRAM FOR THE PROCESSING OF REAL DATA**
S. Pines, H. Wolf, A. Bailie, and J. Mohan 16 Oct. 1964 35 p refs
(Contract NAS5-2535)
(NASA-CR-81150) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A rational method is presented for including the effect of known biases in the equations of motion and in the observations. Basing these expected errors on known physical models, a realistic weighting of the errors in the state is derived, along with the rate of propagation of the errors. A modified set of variational parameters are also derived to eliminate the singularity existing for parabolic and near-parabolic orbits. Considered most significant is the discovery of the effect of computing machine process noise on the covariance matrix of the estimated errors in the state. A method is described of accounting for this effect and enabling the Kalman filter to produce realistic estimates of the state and of the covariance of the estimated errors in the state. Also derived are a set of finite rotations designed to produce changes in the state of the orbit when the changes in the variational parameters may no longer be considered small. M.G.J.

**N67-15326#** Illinois Univ., Urbana. Coordinated Science Lab.
**THE SELECTION OF FAILURE LOCATION TESTS BY PATH SENSITIZING TECHNIQUES**
David Roger Howarth Aug. 1966 58 p refs
(Contract DA-28-043-AMC-00073(E); Grant NSF GK-36)
(R-316; AD-640462) CFSTI: HC $3.00/MF $0.50

A method of deriving test sequences that utilizes path sensitizing techniques is presented. The tests are designed to locate (diagnose) faults in combinational logic networks. The basic strategy is to pick a fault to be tested and sensitize paths, some of which go through the fault. A path is sensitized if the associated test checks for faults along the path; therefore the main objective is to find a set of tests which will determine if the fault has occurred. The proposed method of test selection is compared to other techniques in current use and is shown to produce at least as good a set of tests as the others give even though the path sensitizing method uses less time or less computer memory space. Author (TAB)

**N67-15330#** Mitre Corp., Bedford, Mass.
**XPSTC, A FORTRAN DYNAMIC STORAGE ALLOCATOR**
Joseph E. Sullivan Oct. 1966 77 p refs
(Contract AF 19(628)-5165)
(ESD-TR-66-94; MTR-122; AD-642331) CFSTI: HC $3.00/MF $0.65

The usage and other characteristics of XPSTC, a Fortran compatability storage allocator for the IBM 7030, are discussed. Author (TAB)

# 09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

**N67-14442*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**FREQUENCY GENERATION AND CONTROL: ATOMIC HYDROGEN FREQUENCY STANDARD EVALUATION**
W. Higa *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 81–82 (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

A simple technique has been used to evaluate the stability characteristics of a traveling wave tube (TWT). In addition to providing pertinent information regarding the TWT as a possible follow-up amplifier to the atomic hydrogen maser, the experiment itself is important in establishing a method for future evaluation of the atomic frequency standard. Author

**N67-14450*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**KLYSTRON PROTECTIVE DEVICE**
E. J. Finnegan *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 102–103 ref (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

The mercury pool ignitron crowbar was tested and compared with the triggered spark gap crowbar. The ignitron was connected in parallel with the spark gap crowbar to test its effectiveness. The spark gap alone gave a loud sharp discharge. With the ignitron operating in parallel with it, only a very faint arc was given, thus indicating the ignitron's effectiveness. A comparison of the spark gap and ignitron current wave forms shows that the surge current of the ignitron is nearly 100 times greater and the discharge time is about 100 times faster than the spark gap. The ignitron clears the line of dangerously high currents considerably faster than the spark gap, thus offering greater protection to the klystron. R.N.A.

N67-14656# Gt. Brit. Ministry of Aviation; London. Technical Information and Library Services.
**NON-DETERIORATION OF H.R.C. FUSE-LINKS ON AIRCRAFT**
G. W. Hunton Jun. 1966 15 p
S&T-MEMO-5/66) CFSTI: HC $1.00/MF $0.50

Examination over a five-year period of H.R.C. fuse-links alleged to be defective in service revealed no signs of deterioration or aging of component parts. Examination of a large number of H.R.C. fuse-links in service for over 10 years, some from Valiant aircraft with between 2100 and 2600 flying hours, and some from a Britannia aircraft with over 14,500 flying hours, showed that the fuse-links had not deteriorated and their performance characteristics had not altered. Author

N67-14624*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**SOLID-STATE MICROWAVE ELECTRONICS**
R. P. Rafuse and D. H. Steinbrecker *In its* Res. Lab. of Electron. 15 Oct. 1966 p 15-16 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25

Developments in varactor multipliers and crystal mixers are summarized, including: (1) a new theory for high-order varactor multipliers utilizing step-recovery diodes; (2) production of a varactor multiplier from 225 MHz to 2.25 GHz supplying a power output of 40-60 watts; (3) the obtaining of over-all, single-sideband system noise figures of 2.1 db at 2.7 GHz with experimental GaAs Schottky-barrier diodes and 2.3 db in the same mixer with IN416G diodes. Indications are that a single-sideband noise figure of 3 db is attainable. K.W.

N67-14706# Rome Air Development Center, Griffiss AFB, N. Y. Research and Technology Div.
**A METHOD OF DETERMINING THE COMPARATIVE SHIELDING EFFECTIVENESS OF CABLES, DUCTS AND CONDUIT**
George A. Long Sep. 1966 12 p Presented at the Ann. Wire and Cable Symp., Atlantic City, 7-9 Dec. 1966
(RADC-SP-66-5; AD-640329) CFSTI: HC $1.00/MF $0.50

To make comparative measurements on coaxial, a length of the cable is confined in a shielded room, shorted at the far end and connected to a matching signal generator placed outside the room. The resulting leakage radiation from the cable is then measured with a frequency selective voltmeter. Another cable with different shielding qualities is then subjected to the same measurement and the difference between the two measurements is an indication of the comparative shielding qualities of the cables. Duct and conduit can also be measured for shielding effectiveness in the same manner by making them into a type of coaxial cable. This is accomplished by running a conductor down the interior of the duct or conduit. This conductor is of such a size, and place in such a position to make the enclosure characteristic resistance match the signal generator. A time domain reflectometer is used in assembling these enclosures. With this instrument the positioning of the conductor becomes an easy task because it displays the variation in impedance along the full length of the enclosure. Adjustment for a good match is accomplished easily. The technique is very useful when one type of cable or duct is to be compared with another, or to show up improvements in duct or conduit designs. Author (TAB)

N67-14710# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
**DEVELOPMENT OF QUALIFICATION TECHNIQUES FOR HERMETICALLY SEALED FUSES Technical Memorandum**
Richard C. Coffin May 1966 48 p refs
(Contract NOw-62-0604-c)
(TG-824; AD-639918) CFSTI: HC $2.00/MF $0.50

The report presents the development of qualification tests to be employed on fuses designated for use in satellites. Of particular interest is the development of a means of measuring the transient handling capability of a fuse. Means of measuring the maximum transient repetition rate and of detecting the quality of hermetic seals are also discussed. Included are two appendices, one describing the fuse determination procedure and the other discussing fuse theory. The idea basic to the problem of transient handling capability measurements is to determine the thermal rise time of a fuse and then to limit the possible current transients to less than that value. The thermal rise time, however, is found to be current-dependent. Hence we find, as we would intuitively suspect, that the parameter of interest is not the magnitude of current but the area under the current time curve. Author (TAB)

N67-14785*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**STERILIZABLE ELECTRONIC PACKAGING, CONNECTORS, WIRES, AND CABLING ACCESSORIES**
Alvan G. Fitak, Leonard M. Michal, and Robert F. Holtze *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 343-359 (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

This paper is concerned with sterilization effects on: (1) soldered and welded joints, (2) electronic equipment assembly processes and related materials, (3) electric connectors, and (4) wire and cabling accessories. Preliminary test results are presently available only on the soldered- and welded-joint program. The discussion of the other phases of work consists principally of a description of the test specimens and test methods. The sterilization treatment used was three cycles of 36 hours each at a temperature of 145° C in a dry nitrogen environment, while the ethylene oxide treatment was one cycle of 12 percent ethylene oxide and 88 percent Freon 12 by weight for 24 hours at 24° C and one cycle (same concentration) for 24 hours at 40° C. Author

N67-14882*# Arinc Research Corp., Annapolis, Md.
**MICROELECTRONIC DEVICE DATA HANDBOOK**
Washington, NASA, Aug. 1966 327 p refs
(NASA-CR-80952; NPC-275-1; Publ.-514-01-1-655) CFSTI: HC $3.00/MF $3.25 CSCL 09A

A quick-reference microelectronics handbook is presented as an aid to design engineers, technicians, and parts specialists with little or no experience in microelectronics. Solutions to the specific problems of equipment design engineers must be considered in the context of the cost, schedule, environmental, and other constraints of a particular application and are therefore beyond the scope of this handbook. Information on reliability, manufacturing processes, packaging, specifications, design, and testing is contained. Also included are detailed data on manufacturers and on the performance characteristics of integrated circuits available from stock. S.P.

N67-14908*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**INVESTIGATIONS OF MONOLITHIC INTEGRATED CIRCUIT FAILURES**
Kenneth W. Woodle 21 Nov. 1966 48 p
(NASA-TM-X-53548) CFSTI: HC $3.00/MF $0.65 CSCL 09A

The results of failure analyses performed on a group of monolithic integrated circuits obtained from industry are presented. The devices tested were defective and had been rejected. The most prevalent failure modes and/or causes of rejection of monolithic integrated circuitry were determined, and the capability of performing failure analyses of these devices was developed. The experiment showed the greatest causes of failure to be (1) bonding and (2) open or shorted aluminum interconnects. Other failure

causes found were: too thin a layer of silicon step-up or step-down, poor adherence of aluminum to the silicon, failure to remove all surface contaminents, chipped dice, poor mask alignment, and defects in both the silicon material and the mask. It was determined that proper failure analysis could reveal over 90% of the failures encountered. Author

N67-14975# Philco Corp., Santa Clara, Calif. Microelectronics Div.
**R AND D PROGRAM TO DESIGN AND FABRICATE DIGITAL MONOLITHIC MICROCIRCUITS HAVING AVERAGE PROPAGATION DELAY TIME OF 1 NS Quarterly Summary Report, 1 Apr.–30 Jun. 1966**
30 Jun. 1966 41 p Prepared for Lincoln Lab., MIT, Lexington, Mass.
(Contract AF 19(628)-5167)
(QSR-8; ESD-TR-66-552; AD-642376) CFSTI: HC $3.00/MF $0.65

The report describes the following: (1) The development of 0.1- and 0.05-mil geometry high-speed transistors, (2) The development of saturated and unsaturated high-speed microcircuits, (3) The progress of the array investigation, using 3-, 9-, and 27-bit ECL versions of a parity generator as test vehicles, and (4) The design and fabrication of microcircuit form of an ECL type circuit which is being evaluated by Lincoln Laboratory as part of an experimental computer circuit design. Author (TAB)

N67-15036# Institute of Modern Languages, Inc., Washington, D. C.
**MAGNETIC FIELD DISTRIBUTION IN THE NON-CONTACT ELECTRIC MACHINES WITH EXTERNALLY CLOSED MAGNETIC CIRCUIT [RASPREDFLENYE MAGNITNOGO POLYA V BESKONTACTNYCH ELECTRICHESKYKH MASHINAKH S VNESHNEZAMKNYTYM MAGNITOPROVODOM]**
A. I. Bertinov, V. G. Andreyev, and J. A. Goloobenko Fort Belvoir, Va., Army Engr. Res. and Develop. Labs. [1966] 14 p Transl. into ENGLISH from Elektrotekhn. (Moscow), no. 10, 1965 p 8–11
(Contract DA-44-009-AMC-1563(T))
T-1867-66; TT-66-62196; AD-638666) CFSTI: HC $1.00/MF $0.50

Experimental survey results are disclosed pertaining to the influence upon the distribution of magnetic fluxes and machine heating-up produced by the air gap between the starter pack and the external magnetic circuit. Practical recommendations are made referring to the design of machines of this particular type. Author (TAB)

N67-15047# Harry Diamond Labs., Washington, D. C.
**ERROR ANALYSIS OF RC CIRCUITS COMMONLY USED FOR TIMING**
William E. Ryan and Ira R. Marcus Jul. 1966 37 p
(HDL-TR-1323; AD-640022) CFSTI: HC $2.00/MF $0.50

The report analyzes various RC timing circuits commonly used in ordnance electronic timers. Timing errors are computed as a function of the component tolerances, specified to account for possible manufacturing, aging, and temperature changes. The effect of capacitor leakage is also computed. Author (TAB)

N67-15062# Army Electronics Lab., Fort Monmouth, N. J.
**STUDY OF PRE-OSCILLATOR BEHAVIOR OF CROSSED-FIELD MICROWAVE TUBES**
Park Richmond Aug. 1966 59 p refs
(ECOM-2746; AD-640204) CFSTI: HC $3.00/MF $0.50

The report discusses a series of experiments to study the noise behavior of planar crossed-field beams. The study was divided into two phases. The first phase included the design of the electron optics system, and the construction of several versions of a beam tester to evaluate the design. In the second phase, a design for an experimental noise tube was evolved using the electron optics system developed in the first phase. A tube was also constructed and a series of noise measurements was made during this phase. The noise was measured as a function of longitudinal position along the beam using an X-band cavity for several values of beam position and over a 2-to-1 current range. Noise variations were observed along the length of the beam, but the spacing between noise peaks was not related to the operating parameters in any simple manner. No noticeable growth of noise along the beam was observed; however, an increase in the noise level was noted as the cathode emission became totally space-charge-limited. Author (TAB)

N67-15099# Varian Associates, Palo Alto, Calif.
**RESEARCH ON THERMIONIC ELECTRON EMITTING SYSTEMS Final Report, 16 Jun. 1965–15 Sep. 1966**
I. Weissman 15 Sep. 1966 100 p refs
(Contract NObs-92494)
(Rept.-388-1F; AD-640184) CFSTI: HC $4.00/MF $0.75

The report deals with the synthesis and evaluation of a unique type of thorium, thin-film, thermionic electron emitter. The synthesis procedure involves chemical vapor deposition of a surface layer of a refractory metal onto a thorium dispensing substrate. The unique features of the process are a high degree of preferred uniaxial crystal orientation which can be obtained in the deposited layer, and a measure of control over the particular direction in the layer that is preferentially oriented. By virtue of this orientation, surfaces can be fabricated consisting predominantly of one of the better emitting crystal planes of the particular combination of substrate and adsorbate and enhanced emission thus realized. In the majority of this year's work the grain-oriented surface layers investigated were tungsten. Three different types of dispensers were evaluated, each utilizing a different thermochemical reaction for production of the free thorium necessary to sustain the surface coverage at emitting temperatures. Both thermal stability of preferred orientation and thermionic emission capabilities were evaluated. Methods were evolved for fabricating the emitting structures so as to enhance thermal stability. The emitters tested exhibited a spread of over 15% in their measured values of vacuum work function (3.0 to 3.55 eV). With a single exception they exhibited high thermionic constants (70-120). Thermal stability was good for one type of dispenser evaluated, and relatively poor for the other two. Author (TAB)

N67-15110# Hewlett-Packard Co., Palo Alto, Calif.
**INVESTIGATION AND DEVELOPMENT OF SEMICONDUCTOR-METAL CATHODES**
Lawrence S. Lerner and Robert J. Archer Aug. 1966 68 p refs
(Contract AF 19(628)-5946)
(AFCRL-66-479; SR-1; AD-641614) CFSTI: HC $3.00/MF $0.75

With a view to the development of a semiconductor-metal cathode, investigations have been undertaken aimed at the production of Schottky barriers of height $\phi_{ms} > \text{or} = 1.5$ eV on semiconductor materials of controllable properties. A brief survey has been made of the characteristics of Schottky barriers on ZnO and BeP, and an intensive study of the GaAs(1-x)Px system has been begun. It has been established that etching with H2SO4-H2O-H2O2 (etch a0 prior to vacuum deposition of gold or aluminum dots results in barriers of consistent properties, and correlation with direct ellipsometric measurements of surface film thickness has been made. The etch A treatment reduces the film thickness from nearly equal to 30 A (after careful solvent cleaning) to nearly equal to 12 A, or close to the best values obtained to

date on Si. Barrier heights up to approximately 1.3 eV have been obtained to date on etched GaAs (.60)P (.40). In an attempt to understand in detail the discrepancies between the barrier heights measured by means of capacitance vs voltage, current vs voltage, and photoemissive yield measurements, and to take possible experimental evaluation of true barrier height, a theoretical treatment of Schottky barriers is presented which includes explicitly the effects of the interfacial dielectric film. Author (TAB)

N67-15260*# Stanford Research Inst., Menlo Park, Calif.
**RESEARCH ON COLD CATHODES Final Report**
D. V. Geppert and B. V. Dore May 1966 54 p refs
(Contract NAS5-9581; SRI Proj. 5511)
(NASA-CR-81138) CFSTI: HC $3.00/MF $0.65 CSCL 09A

The requirements for the semiconductor, metal surface film and activator for the surface-barrier cathode are reviewed. The studies on GaP crystals and GaP/metal surface-barrier diodes conducted during the course of the program are reveiwed and discussed. The activation experiments involving the evaporation of thin films of BaO on various metals are then reviewed and discussed. The recent experiments on nickel substrates indicate very-high-quantum-efficiency photoemission at elevated cathode temperatures. The promising emission results obtained during the last quarter from transverse field emitters are presented. Alphas approaching 50 per-cent were obtained by subjecting thin films of evaporated BaO to high transverse fields ($>10^5$V/cm). These cathodes were operated under dc conditions, and emission current densities as high as about 1 amp/cm$^2$ were obtained. Author

N67-15273# Army Electronics Labs., Fort Monmouth, N. J.
**PLASMA GENERATORS FOR MICROWAVE DEVICES Final Report**
Maurice Weiner, Robert M. True, and Edward V. Edwards Aug. 1966 52 p refs
(ECOM-2740; AD-639715) CFSTI: HC $3.00/MF $0.50

An experimental study has been undertaken to determine methods for producing a high-density plasma suitable for microwave applications. The Penning Ionization Gauge (PIG) discharge and lithium ion emission for plasma synthesis have been investigated. Langmuir probe measurements on the PIG were obtained under various conditions of anode current, magnetic field, gas pressure, and probe position. Radial and longitudinal profiles of electron density, electron temperature, and plasma potential were obtained. The lithium ion emission studies indicate the need for greater ion current densities than those presently achieved. Author (TAB)

N67-15285# Sprague Electric Co., North Adams, Mass.
**PRODUCTION ENGINEERING MEASURE FOR MECHANIZATION OF HIGH RELIABILITY CAPACITORS Quarterly Report, 1 Apr.–30 Jun. 1966**
H. F. Phillips and G. E. Walters 30 Jun. 1966 11 p refs
(Contract DA-36-039-AMC-01460(E))
(QR-14; AD-639736) CFSTI: HC $1.00/MF $0.50

Modifications were completed during this period on four of the machines and a 500-capacitor trial run was made. Redesign was essential on many parts of Conveyor B before production could continue. The machinery was moved to a new environment and a 1200-capacitor trial run will be made early in the next quarter. Author (TAB)

N67-15286# Bendix Corp., Holmdel, N. J. Semiconductor Div.
**PRODUCTION ENGINEERING MEASURE FOR IMPROVEMENT OF PRODUCTION TECHNIQUES TO INCREASE THE RELIABILITY OF SILICON TRANSISTOR TYPE 2N3065 Quarterly Progress Report, 1 Apr.–30 Jun. 1966**
Herman W. Baer, C. Carroll, J. Mechura, J. Papa, and H. Sivik 30 Jun. 1966 68 p refs
(Contract DA-36-039-AMC-96171(E))
(Rept.-2; QPR-2; AD-639841) CFSTI: HC $3.00/MF $0.75

During the quarter investigations were made in the following process areas: geometry studies, mechanization studies, photo resist studies, diffusion studies, wafer requirement studies, contact metallization studies, assembly studies, and device rating studies. Author (TAB)

N67-15339# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
**TUNED INTEGRATED CIRCUITS Quarterly Report, 1 Apr.–1 Jul. 1966**
W. E. Newell, S. M. Zalar, and B. R. Mc Avoy Sep. 1966 72 p refs
(Contract DA-28-043-AMC-02045(E))
(Rept.-66-9F1-NEWSC-R1; ECOM-02045-1; QR-1; Rept.-1; AD-639667) CFSTI: HC $3.00/MF $0.75

The purpose of the contract is to investigate tuning devices and physical phenomena which could lead to stable frequency selective silicon integrated circuits over the range from 150 kHz to 150 mHz. This first quarterly report includes the description of the method for producing stoichiometric, well-oriented and insulating thick films of CdS by vacuum co-evaporation, discusses the structural hexagonality of the produced CdS films and describes the experimental analysis of piezoelectric resonances. TAB

# 10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N67-14341# Joint Publications Research Service, Washington, D. C.
**TECHNICAL CYBERNETICS, NUMBER 5, 1966**
3 Jan. 1967 8 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk: Tekhn. Kibernetika (Moscow), no. 5, Sep.–Oct. 1966 p 1–176
(JPRS-39381; TT-67-30032)

In the articles presented, consideration is given to problems of optimal control, random processes, queueing systems, synthesis, voice and speech recognition, pattern recognition, and information processing. For individual abstracts, see N67-14342–N67-14364.

N67-14342# Joint Publications Research Service, Washington, D. C.
**INFORMATION VALUE FOR THE OBSERVATION OF A RANDOM PROCESS IN SYSTEMS CONTAINING FINITE AUTOMATA**
R. L. Stratonovich *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 1–17 refs (See N67-14341 05-10)

The theory of information value is applied to the case where the random process $[x_k]$ comes to the input of a receiving system which develops the value of the process $[z_k]$. It is assumed that a finite automaton which has r input values, k states and s output values enters into the makeup of the system as an invariant link. The carrying capacity of the automaton is calculated after which the theory of information value permits finding of the principle limits for the loss level, that is, evaluation of the quality of operation of the system as a whole. Author

N67-14343# Joint Publications Research Service, Washington, D. C.

**THE VITALITY OF COMPLEX SYSTEMS**

B. S. Fleyshman *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 18–31 refs (See N67-14341 05-10)

The capacity of a system to actively withstand the harmful effect of the external environment is examined, with both the operating and the protective elements of the system considered. A stochastic statement of the problem is presented, and a two-step solution to it is given. The independent effects of the protective elements are investigated, and formulas for optimizing the protective structure of the system are derived. It was concluded: (1) The harmful effect of the external environment on the system may be neutralized by introducing redundant protective elements. (2) Optimal behavior and structure are found for the environment acting informally on a system filled uniformly with elements. (3) Optimization of the system increases by several orders the number of harmful active environmental agents required for putting the system out of order; conversely, it lowers the number of protective elements required to maintain operation. M.G.J

N67-14344# Joint Publications Research Service, Washington, D. C.

**THE CONTROL OF SOAKING PITS USING THE METHOD OF PATTERN RECOGNITION**

Yu. S. Kotov and B. S. Pritsker *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 32–37 refs (See N67-14341 05-10)

The problem of recognition of a class of internal states of an object with respect to readings from indirect sensors is investigated. The signs are isolated which are suitable for recognition with determinate restrictions on the form of the regions of the classes. Experimental data are presented from the discrimination of classes of states of a specific object (the recovery soaking pit), and the problem of control of an object with the use of a recognition system is stated. Author

N67-14345# Joint Publications Research Service, Washington, D. C.

**AN ISOPERIMETRIC PROBLEM OF SYNTHESIS OF OPTIMAL CONTROL**

V. N. Kalinin *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 38–45 refs (See N67-14341 05-10)

The problem is investigated of synthesis of optimal control of an object, the motion of which is determined by a system of ordinary differential equations under the condition that additional isoperimetric conditions are imposed on the control process. It is shown that the optimal control (the solution of the synthesis problem) is a functional of the motion of the system preceding the investigated state, and not a function of this state as in the case of the absence of the indicated isoperimetric conditions. The simplest problem of isoperimetric synthesis is solved for an object of second order. The minimized functional is selected in the form of an integral of the modulus of the control effects, and the isoperimetric condition is fixing of the length of the process. Author

N67-14350# Joint Publications Research Service, Washington, D. C.

**OPTIMAL CONTROL OF SWITCHING ON RESERVE ELEMENTS**

I. B. Gertsbakh *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 106–113 refs (See N67-14341 05-10)

A reserved system is investigated, the testing of which may take place only at determinate points in time. The number of elements included in the hot reserve after the next check is selected with the intention of minimizing the probability of system failure during the course of the given operating time. The algorithm is presented for finding the optimal policy for switching on the reserve elements, and some of its properties are investigated. Author

N67-14355# Joint Publications Research Service, Washington, D. C.

**A NEW ALGORITHM FOR CONSTRUCTING A BASE IN A LANGUAGE OF REGULAR EXPRESSIONS**

B. G. Mirkin *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 161–170 refs (See N67-14341 05-10)

An algorithm is proposed, and an evaluation is offered of the complexity of the base obtained. The Spivak–Brzozowski result concerning the application of the concept of a base to abstract synthesis of automata is generalized for the case of nondeterministic automata. The discussion is illustrated by an example. Author

N67-14356# Joint Publications Research Service, Washington, D. C.

**THE PROBLEM OF SYNTHESIS OF FORMAL NEURONS**

I. B. Gutchin and A. S. Kuzichev *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 171–175 refs (See N67-14341 05-10)

Analytical expressions for the synthesis of formal neurons are constructed, in which all the branches of the neurons are investigated sequentially. In the proposed method, fibers of the inhibition–inhibition types are introduced (that is, the inhibiting fiber ends in another inhibiting fiber). It is pointed out that this simplifies the procedure as the total required minimum number of fibers is lowered. M.G.J.

N67-14358# Joint Publications Research Service, Washington, D. C.

**OPTIMAL FILTRATION WITH RESPECT TO THE MINIMAX CRITERION**

D. S. Irger *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 193–203 refs (See N67-14341 05-10)

The problem of optimal extraction of a useful signal from a mixture of it with noise under conditions of absence of a priori statistical information about the signal is investigated. The game approach is used in the minimax version. The equation for the optimal filter applicable to the general criterion of accuracy of filtration for an arbitrary correlation function of noise is obtained. Examples are presented demonstrating the difference in the minimax approach and the classical theory of filters. Author

N67-14359# Joint Publications Research Service, Washington, D. C.

**THE APPROXIMATE METHOD FOR DETERMINATION OF THE DISTRIBUTION MOMENTS OF THE GREATEST VALUES IN RANDOM PROCESSES OF FINITE LENGTH**

L. A. Blagonravov *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 204–209 refs (See N67-14341 05-10)

Recurrent formulas are obtained with the help of which the dependency of the distribution moments on the number of overshoots in sequence is determined. The results may be used in the analysis of the operation of converters of continuous signals into discrete signals with overshoot of the maximum values in the given discreteness interval. Author

N67-14360# Joint Publications Research Service, Washington, D. C.

**A PROBLEM IN ANALYTICAL DESIGN OF THE OPTIMAL REGULATOR**

V. I. Tolokhov *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 210–215 refs (See N67-14341 05-10)

Formulas are presented for calculation of the parameters of the optimal control law and the weight coefficients of the quadratic formula according to the data on the parameters of the system, the initial disturbances, and the properties of the desired transient process. Author

**N67-14361#** Joint Publications Research Service, Washington, D. C.

**QUASIINVARIANT CONTROL OF FORCED MOTION OF LINEAR OBJECTS WITH VARIABLE PARAMETERS**

V. I. Utkin *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 216–223 refs (See N67-14341 05-10)

The problem of synthesis of an automatic control system is investigated with variable structure in the phase space of the coordinates of which there is a slip hyperplane. In the system constructed in this way, beginning with some point in time, motion arises and is not curtailed which is invariant both with respect to the parameters of the object which vary within a broad range and the external disturbances applied to it. Author

**N67-14362#** Joint Publications Research Service, Washington, D. C.

**THE THEORY OF FORCES PROCESSES IN SELFADJUSTING SYSTEMS WITH AN AUXILIARY OPERATOR**

Yu. I. Alimov and V. K. Obabkov *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 224–235 refs (See N67-14341 05-10)

The exact equations for the conditions of self-adjustment are assumed which differ from the quasi-stationary ones. A comparison is presented with equations obtained by freezing of the coefficients. The linear equations are derived in versions which are suitable for efficient investigation of stability. Specific examples are investigated. Author

**N67-14363#** Joint Publications Research Service, Washington, D. C.

**AN OPTIMAL CONTROL PROBLEM FOR SYSTEMS WITH DISTRIBUTED PARAMETERS**

E. M. Vaysbord *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 236–242 refs (See N67-14341 05-10)

For solving the given problem, an equation is formulated in which the coefficients for high order derivatives depend on the control. The required condition of the minimum is formulated, and a theorem is presented which permits some qualitative conclusions to be drawn about the properties of optimal control, and a check on the required condition of optimality. Optimization of the random search for the extremum value of functions of many variables is also considered. M.G.J.

**N67-14675#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

**DIFFERENCE EQUATIONS: ADAPTIVE CONTROLLER DESIGN TECHNIQUE**

Theodore T. Stein, Jr. (M.S. Thesis) Jun. 1966 91 p refs (GGC/EE/66-18; AD-639693) CFSTI: HC $3.00/MF $0.75

An identification means for adaptive control systems is an average difference equation approximation for the vehicle transfer function. Solution of the difference equation, accomplished in the control computer of the adaptive system, determines which of several fixed compensators to use for existing flight conditions. The difference equation derived for the X-15 longitudinal dynamics is analyzed mathematically for various inputs. The X-15 pitch-rate loop and control computer is simulated on analog and digital computers. The difference equation solution error becomes large after two or three seconds. Exact difference equations for given flight conditions are generally more accurate. Significant errors still result after several seconds. Computer results indicated the difference equation solution was relatively accurate for not more than two or three seconds. Author (TAB)

**N67-14722#** Illinois Univ., Urbana. Coordinated Science Lab.

**MATRIX SWITCHES AND ERROR CORRECTING CODES FROM BLOCK DESIGNS**

Lalit Rai Bahl Aug. 1966 48 p refs (Contract DA-28-043-AMC-00074(E); Grant NSF GK-890) (R-314; AD-640457) CFSTI: HC $2.00/MF $0.50

Methods of obtaining matrix switches from block designs were formulated by Singleton and Neumann. The first part of the report extends Singleton's method for designing unipolar switches to the design of bipolar switches. A new class of low noise switches is obtained by permutation of the winding matrix of noiseless switches and it is shown how these new switches are related to block designs. The latter part of the report is concerned with methods of obtaining error detecting and error correcting codes from block designs. Some of these codes are found to be optimal. Author (TAB)

**N67-14953#** Motorola, Inc., Phoenix, Ariz. Semiconductor Products Div.

**INTEGRATED CIRCUITS FOR FIELDATA COMPUTERS Quarterly Report, 1 Feb.–30 Apr. 1966**

Ury Davidsohn, Faith Lee, and Jim Solomon Oct. 1966 25 p ref (Contract DA-28-043-AMC-01630(E)) (ECOM-01630-3; QR-3; Rept.-3; N-21; AD-642355) CFSTI: HC $3.00/MF $0.65

Designs previously evaluated in standard units isolated by diffusion techniques are now being incorporated in wafers using dielectric isolation. Translational masks have been completed and used. Ultrasmall devices have been processed using higher sheet resistances and dry oxygen drive-in. Lateral pnp action is being studied as a method of 'sinking' excess collector stored-charge. A discrete breadboard of the TTL gate design shows switching times and power drain approaching those specified. The linear requirement for this contract is discussed, outlining possible circuit configurations and design values. An amplifier circuit is broken down into its stages and detailed design is outlined. Author (TAB)

**N67-15011#** Lincoln Lab., Mass. Inst. of Tech., Lexington.

**THEORY AND DESIGN DATA FOR UNIFORMLY DISSIPATIVE, DOUBLY TERMINATED BANDPASS AND LOWPASS FILTERS**

John W. Craig 24 Feb. 1966 199 p refs (Contract AF 19(628)-5167) (ESD-TR-66-46; TR-411; AD-642747) CFSTI: HC $3.00/MF $0.65

Design data are given in the form of curves of the normalized parameters for the exact design of uniformly dissipative, doubly terminated bandpass and lowpass filters with Butterworth, Chebyshev, or Bessel transfer functions having two, three, four, or five poles. For the Chebyshev filters, pass-band ripples of 0.001, 0.1, 0.03, 0.10, 0.30, and 1.0 dB are included. Curves are also given for gain, phase, group delay, and transient response, most of which are not readily available elsewhere. A complete theoretical development of the design is given, and the solution for the five-pole case is apparently new. Multiple solutions for the design parameters are discussed in the light of modern network synthesis, and the correspondence between the two is established. Author (TAB)

**N67-15048#** Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

**NUMERICAL METHOD OF DETERMINING TRANSIENT PROCESSES IN NONLINEAR ELECTRIC NETWORKS ON DIGITAL COMPUTERS**

A. V. Vul'fson 19 Aug. 1966 13 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Energ. i Transp. (USSR), no. 1, 1966 p 64–70 (Contract NOw-62-0604-c) (TG-230-T487; TT-66-62383; AD-639908) CFSTI: HC $1.00/MF $0.50

A method is proposed for determining transient processes in electric networks with one nonlinearity and an arbitrary linear part. The initial data for solution are the transfer functions and the impedances of the linear part of the network. The results of a check on the URAL-2 computer are given. Author (TAB)

N67-15082# Lincoln Lab., Mass. Inst. of Tech., Lexington.
**GENERAL RESEARCH Quarterly Technical Summary Report, 1 May–31 Jul. 1966**
Frederick C. Frick, V. Alexander Nedzel, Stephen H. Dodd, Melvin A. Herlin, Jerome Freedman et al 15 Aug. 1966 48 p refs
(Contract AF 19(628)-5167)
(ESD-TR-66-401; AD-639570) CFSTI: HC $2.00/MF $0.50

This Quarterly Technical Summary consolidates the reports of Division 2 (Data Systems), Division 3 (Radio Physics), Division 4 (Radar), Division 7 (Engineering), and Division 8 (Solid State) on the General Research Program at Lincoln Laboratory. Author (TAB)

N67-15092# Stanford Univ., Calif. Systems Theory Lab.
**AN APPROACH TO THE TIME-VARYING SENSITIVITY PROBLEM**
B. D. O. Anderson and R. W. Newcomb Jun. 1966 21 p refs Presented at the 1966 Fall SIAM Meeting on the Appl. of Generalized Functions to System Theory, Stonybrook, N. Y., 12–14 Sep. 1966
(Contract Nonr-225(83); Grant AF-AFOSR-337-63)
(SEL-66-006; TR-6560-1; AD-642151) CFSTI: HC $3.00/MF $0.65

By means of the theory of distributional kernels, a sensitivity matrix S(T,TAU) is introduced which relates changes in open and closed loop outputs due to changes in a plant parameter. Through equivalence with a passive network scattering matrix, the properties of S for sensitivity improvement are determined. Author (TAB)

N67-15163# Joint Publications Research Service, Washington, D. C.
**THE THEORY OF PERT AND CONTROL SYSTEMS**
Yu. P. Krivenkov 4 Jan. 1967 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 171, no. 2, 1966 p 302–305
(JPRS-39392; TT-67-30043)

Consideration is given to the PERT method for handling network models, and a process model of the operation leading to $\beta$-distribution is described. The values characterizing the distribution are analyzed and a new definition is proposed for the basic evaluations permitting traditional use of the system, and, in addition, the noncontradictory construction of the distribution function with respect to these values. An investigation of the limiting case of $\beta$-distribution in the form of $\gamma$-distribution is also included. A.G.O.

N67-15164# Joint Publications Research Service, Washington, D. C.
**MACHINES FOR CENTRALIZED CONTROL**
I. M. Shenbrot 4 Jan. 1967 140 p refs Transl. into ENGLISH of the book "Mashiny Tsentralizovannogo Kontrolya" Moscow, "Nauka" Publishing House, 1966 p 1–192
(JPRS-39407; TT-67-30057)

This book contains a systematic description of machines produced for centralized control by the industry of the USSR. It describes the structures of machines for centralized control, operating principles, designs, and the characteristics of the machine units. It also describes the structure of industrial machines used for centralized control and their specifications. This book is intended for a wide circle of specialists in the field of automation of production and designing of automation facilities; also for senior students studying the respective special courses in institutions of higher education. Author

N67-15173# Joint Publications Research Service, Washington, D. C.
**SPECIFIC REQUIREMENTS OF AUTOMATIC CONTROL SYSTEMS DISCUSSED**
N. B. Levitt and V. K. Podgaynyy 10 Jan. 1967 7 p Transl. into ENGLISH from the book "Avtomatika" Moscow, 1964 p 190–195
(JPRS-39474; TT-67-30124)

Although the basic requirement which must be unconditionally fulfilled in all cases is stability of a system, it is noted that control realized even by a stable system may be unsatisfactory. Quality of control, which is determined by the accuracy, that is, the value of the static and dynamic errors of the system, the overcorrection, the reaction speed of the system, and the duration of the transient condition, must be attained. The relation of these quality indices to each other and the dependence to a significant extent on the transfer coefficient of the system are demonstrated. A.G.O.

N67-15265# Stanford Univ., Calif. Systems Theory Lab.
**THE INVERSE PROBLEM OF OPTIMAL CONTROL**
B. D. O. Anderson Apr. 1966 30 p refs
(Contract Nonr-225(83))
(SEL-66-038; TR-6560-3; AD-639704) CFSTI: HC $2.00/MF $0.50

The relation is explored between linear feedback laws chosen to reduce the sensitivity of a linear time-invariant system to plant parameter variations, and linear feedback laws derived on an optimal control basis from quadratic loss functions. A general equivalence between the two types of design is established for multiple-input, multiple-output systems. The sensitivity improvement can be calculated for optimally design systems, and a quadratic loss function can be found for a system designed to reduce the sensitivity to plant parameter variations. Author (TAB)

N67-15267# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
**INVESTIGATION OF THE CHARACTERISTICS OF A NEURON-LIKE NETWORK USED TO CONTROL AN OPPOSING-ACTUATOR DEVICE**
James Thomas Medley (M.S. Thesis) Jun. 1966 58 p refs
(GGC/EE/66-14; AD-639706) CFSTI: HC $3.00/MF $0.50

A neural network controlled muscle system is designed and built using an electronic neuron model as the basic element to form the network, and an opposing-actuator device, composed of two electromagnetic solenoids, as the prime mover. The system is analyzed with the help of a variable impedance muscle stimulator previously used for live muscle testing. The static and dynamic characteristics of the model resemble those of a live muscle. Parameters of the network are varied to determine their effects on the system. Author (TAB)

N67-15333# Naval Research Lab., Washington, D. C.
**USING A PARALLEL-T NETWORK FOR DEVELOPING QUADRATURE VOLTAGES AT VARIABLE FREQUENCIES Interim Report**
S. O. Bailey 30 Aug. 1966 30 p refs
(NRL-6440; AD-641985) CFSTI: HC $2.00/MF $0.50

Two voltages phased in quadrature are developed at special junctions in a twin-T or parallel-T resistance-capacitance network. Heretofore, this network has been utilized for only its null transmission characteristics. Utilization of these properties remain essential when considering some complete circuits. The two voltages are produced with phase relation that is not sensitive to changes of the driving frequency; however, the amplitude ratio of the two voltages is related to the null frequency. A variable frequency oscillator which generates two voltages phased in quadrature can be constructed using a symmetric parallel-T network. The operating frequency may be manually selected in somewhat the same manner as presently done with conventional Wien-bridge oscillators. This oscillator may be converted into a generator of voltages with arbitrary phase relations which may be simply controlled. By making connections to all junctions of the parallel-T network it is possible to construct frequency-selective amplifiers which operate through narrow bandwidths and produce well-filtered quadrature voltages. These voltages should be useful for producing undistorted circular time traces on oscilloscopes. With connections to all junctions in a parallel-T network it is possible to construct frequency discriminators with output voltages that vary in a predictable manner as the input frequency varies through a maximum-to-minimum ratio of four to one. The bandwidth together with the upper and lower limit of the output voltage can be altered by incorporating a frequency-selective amplifier as a part of the frequency discriminator. Author (TAB)

# 11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

**N67-14454*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**FLIGHT PROJECT SUPPORT**
J. Orbison and W. J. Kinder *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 115-120 refs (See N67-14421 05-07) CFSTI: HC$4.25/MF$1.50

Flight project support is described for deep space station (DSS) engineering and operations. Mention is made of Lunar Orbiter I high- and low-orbit picture taking sequences and time synchronization correlations between stations using the Mark I ranging subsystem. The Pioneer DSS, which acted as a backup to the Echo DSS for Pioneer VI, is described. In addition, the missions of Pioneer VI, Mariner IV, and Surveyor B are discussed. Implementation of the MSFN Apollo backup station system is considered; and functions, such as acquiring and tracking spacecraft signals, and transmitting voice, data, and ranging signals to spacecraft, are enumerated. S.P.

**N67-14455*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**FACILITY CONSTRUCTION AND EQUIPMENT INSTALLATION**
J. Orbison and H. L. Richter *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 120-126 refs (See N67-14421 05-07) CFSTI: HC$4.25/MF$1.50

Implementation of the Mars, Pioneer, Echo, and Venus deep space stations (DSS) is described. The installation of the S-band system is reported for the Mars DSS operation, and extensive station changes are briefly reviewed for the Pioneer DSS. Installation of dc tachometers on the deep space information facility 85-ft polar antennas is described as a means of improving the interface of rate feedback signals with manned space flight network servo electronics and upgrading the rate loops of the standard tracking antennas. S.P.

**N67-14456*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**DSIF STATION CONTROL AND DATA EQUIPMENT**
R. Flanders, G. Jenkins, A. Burke, H. Baugh, and W. Frey *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 126-129 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

The deep space information facility (DSIF) station control and data equipment is to be implemented to provide increased support for the flight projects as a part of the DSIF station equipment. In the performance of this objective, the equipment is to provide the capability for processing spacecraft telemetry and command data in direct support of the mission, and for station monitoring, time and frequency tagging, and antenna pointing as a part of the mission independent functions. The specific subsystems involved with these tasks are the Antenna Pointing Subsystem, Digital Instrumentation Subsystem, Station Monitor and Control Console, Telemetry and Command Processor, and the Frequency and Timing Subsystem. The function of each of these subsystems, together with the current status, is described. Author

**N67-14457*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**VENUS STATION OPERATIONS**
M. A. Gregg, E. B. Jackson, and A. L. Price *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 129-132 (See N67-14421 05-07) CFSTI: HC$4.25/MF$1.50

Experimental activities, subsystem performance, and system improvements associated with the Venus station are described. In cooperation with the Mars station the Venus station tracked Mariner IV returning telemetry data, spectograms, and two-day doppler data to be utilized in orbit analysis. A bistatic planetary radar experiment with Mercury as the target was conducted at the Venus station. Performance of the 100-kW transmitting systems and X-band receiving systems is mentioned. S.P.

**N67-14648*#** Illinois Univ., Urbana. Aeronomy Lab.
**AERONOMY FIELD STATION**
R. David et al *In its* Res. in Aeronomy 31 Mar. 1966 p 113-124 (See N67-14641 05-13) CFSTI: HC$4.00/MF$1.00

Design and construction are discussed for the antenna systems for an aeronomy field station that are to operate in conjunction with instruments for the measurement of vertical incidence absorption, ionospheric drifts, and partial reflections. A four-pole circularly polarized array for use in these measurements was designed and erected, and three coaxial loop antennas for use as receiving antennas for the drift measurements were designed and constructed. Initial construction was begun on very large high gain antenna rays for the partial reflection measurements. M.W.R.

**N67-14698#** Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf (Austria).
**APPARATUS FOR MOTION TRANSFER IN A VACUUM SYSTEM [VORRICHTUNG ZUR BEWEGUNGSUBERTRAGUNG IN EIN VAKUUM SYSTEM]**
F. W. Edl [1966] 6 p In GERMAN Submitted for Publication (SGAE-PH-41/1966)

A device is described which makes it possible to transfer, by a combination of simple constructional elements, 6 different motions in a vacuum system. Author (NSA)

**N67-14733#** Lincoln Lab., Mass. Inst. of Tech., Lexington.
**LINCOLN ACCELERATOR LABORATORY**
Charles L. Mack, Jr. 2 Sep. 1966 36 p
(Contract AF 19(628)-5167)
(ESD-TR-66-430; TN-1966-12; AD-639962) CFSTI: HC $2.00/MF $0.50

A complete technical description of the Lincoln Accelerator Laboratory is given. The primary purpose of the laboratory is to conduct radiation-effects studies for space vehicles and components. Particle fluxes up to 88 inches in diameter are provided in a solar-vacuum chamber. These can be either monochromatic electrons at any energy from 300 kev to 4 Mev; electrons distributed in a Van Allen energy spectrum from 40 kev to 4 Mev, or monochromatic protons at any energy from 50 kev to 4 Mev. The general-purpose capabilities of the laboratory are described, equipment listed, and information concerning the facilities is given to enable the investigator to design his experiment for greatest convenience and compatibility. Author (TAB)

**N67-14795*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**STERILIZATION FACILITIES**
B. C. Lam (NASA, Washington), and Abe F. Cohen *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 543-546 (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

A small experimental assembly and sterilization laboratory (EASL) and a sterilization and assembly development laboratory (SADL) are described. The EASL provides a facility for evaluating the effects of rigorous constraints on personnel and material during the fabrication of small modules and subassemblies. The SADL will conduct developmental experiments on a full scale model of the Voyager capsule. Supporting features of SADL include a personnel processing area containing a Class 100 laminar crossflow dressing room; a complete microbiological assay laboratory; receiving, cleaning, and decontamination spaces; an OSE area; a large sterilization oven; and a combination ethylene oxide decontamination chamber and airlock. Both EASL and SADL use laminar downflow to obtain a Class 100 clean room environment in the working area. R.N.A.

**N67-14796*#** Exotech, Inc., Washington, D. C.
**SPECIAL PROBLEMS IN SPACECRAFT STERILIZATION**
William C. Cooley and Samuel Schalkowsky *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 547-557 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

Special problem areas are discussed which require additional effort as an aid in the development of a broadly based sterilization technology. Consideration is given to the conflicting requirements of sterility assurance and equipment reliability and to the development of a rationale for achieving a practical balance between the two. It is shown that the present requirements for heat decontamination of nonassayable subsystems are too conservative and probably would produce needless degradation of reliability. It is pointed out that the decision not to sterilize Mars flyby vehicles is not consistent with the sterility assurance required for landers. The role of thermal effects and compatibility testing is discussed in terms of the information which is needed to support the development of sterilizable hardware and the specification of appropriate sterilization procedures for Mars landing missions. Radiation as an alternate for heat sterilization is discussed including factors which enter into determining the feasibility and practicability of radiation sterilization by the use of gamma rays or X-rays. Author

**N67-14820*#** General Dynamics/Convair, San Diego, Calif.
**CENTAUR PAD SAFETY REPORT FOR LAUNCH COMPLEX 36A AND 36B AIR FORCE EASTERN TEST RANGE TEST RANGE, REVISION A**
G. W. Hofeller 21 May 1965 177 p refs
(Contract NAS3-3232)
(NASA-CR-80916; GD/C-BNZ-65-021, Rev. A) CFSTI: HC $5.00/MF $1.00 CSCL 22D

This report presents detailed safety-oriented data to be used during the preparation, launch, and postlaunch operations of Centaur vehicles at the Eastern Test Range launch Complex 36A and 36B. The scope of this plan is limited to a discussion of compliance with pad safety requirements applicable to Atlas/Centaur launch vehicles and associated ground equipment, particularly the handling and installation of ordnance items and hazardous systems. Detailed handling procedures are prepared separately. Author

**N67-14836#** Union Carbide Corp., Oak Ridge, Tenn.
**HOT PRESSES FOR GLOVE BOX AND MANIPULATION CELL**
T. C. Quinby, E. E. Pierce, and R. E. McHenry *In* DuPont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 9 p refs (See N67-14821 05-22) CFSTI: $7.00

A miniature hot press, intended for research and development and for glove-box operation, consists of three components: the heater, which includes a carbon resistance element and variable-voltage, high-amperage power supply; the die column, which includes the die assembly and the hydraulic cylinder for applying pressure to the die plunger; and the containment shell, which confines the heated zone and contains the vacuum or other atmosphere. The production hot press was designed for fabrication of sources up to 3-in. in dia in a manipulator cell. The press consists of the frame assembly, which allows the furnace to be tilted for loading and contains the hydraulic ram; the furnace, which includes the r-f work coil, the graphite susceptor, and the furnace insulation and shell; and the die column including the die assembly, plungers, and push rods. NSA

**N67-14881*#** National Aeronautics and Space Administration, Washington, D. C.
**APPROVAL OF FACILITY PROJECTS**
1 Jul. 1966 37 p
(NASA-TM-X-59259; NHB-7330.1) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A handbook, which sets forth policies and procedures for facility management, is presented. It deals with the manner in which projects for facility acquisition, design, construction, repair, and alteration are approved. Such subjects as policy and authority, programming, and procedures for obtaining approval are discussed. Provisions are applicable to all NASA installations. S.P.

**N67-14896*#** Melpar, Inc., Falls Church, Va.
**HAZARDS MONITORING AT NASA MERRITT ISLAND LAUNCH AREA, VOLUME III Final Report**
Nov. 1965 16 p
(Contract NAS10-2009)
(NASA-CR-80961) CFSTI: HC $3.00/MF $0.75 CSCL 22D

A report on the data display and transmission operations safety console (OSC) for the firing rooms of Launch Complex 37 is presented. The status, display, and communications consoles are illustrated, and the digital data transmission systems required for the control and display functions is described. It is concluded that the hazards monitoring data display and transmission system should be provided with the highly flexible and extensive communications facility. Four television monitors should be included with existing systems to provide the OSC with information from fire detection systems, weather briefings, and critical areas of the launch complex. S.P.

**N67-14898*#** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
**TECHNICAL MANUAL BASE SUPPORT SERVICES CONTRACTOR BASE UTILITIES OPERATION AND MAINTENANCE, VOLUME 5**
1 Apr. 1966 97 p
(NASA-TM-X-59265; TM-431-TWA, Vol. 5) CFSTI: HC $3.00/MF $1.30 CSCL 22D

A technical manual of base utilities operation and maintenance is presented. Operating procedures for the high voltage power distribution system are outlined, and the steps necessary for providing sufficient emergency and standby power are presented. Requirements for treatment of water used in the air-conditioning system cooling tower are delineated, and instructions for the operation and maintenance of the sewage disposal and water treatment systems for the launch complex are established. Finally, operations and maintenance procedures for compressed air systems are described. S.P.

**N67-14899*#** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
**TECHNICAL MANUAL BASE SUPPORT SERVICES CONTRACTOR SHOPS, FIELD ENGINEERING, AND AREA SERVICES, VOLUME 6**
1 Apr. 1966 58 p
(NASA-TM-X-59264; TM-431-TWA, Vol. 6) CFSTI: HC $3.00/MF $0.75 CSCL 22D

Functional responsibilities of the base support services contractor are delineated in a manual pertaining to shops, field engineering, and area services. The procedure for maintaining facilities and equipment in specified areas is presented, and elevator maintenance and trouble call procedures are set forth. Reponsibilities for maintaining launch complex 39 and the fluid test complex are enumerated, and an outline of low voltage power distribution and lighting is included. S.P.

**N67-14904*#** Union Carbide Nuclear Co., Oak Ridge, Tenn. Gaseous Diffusion Plant.
**HEAT EXCHANGER TEST EXPERIMENTAL APPARATUS. SECTION I: HELIUM HEATER. SECTION II: HELIUM CIRCULATOR Summary Report**
D. W. Burton, J. O. McCullough, and R. W. Ulm [1966] 64 p refs
(NASA Order C-60041-A; Contract W-7405-ENG-26)
(NASA-CR-72045; K-D-1870) CFSTI: HC $3.00/MF $1.30 CSCL 13A

The design and analysis of a molybdenum tube used to heat helium to 2500°F for use in a high temperature experimental heat exchanger test facility is described. The tube is enclosed in a pressure vessel, and the inner vessel walls are protected by radiation shields. The heater is energized at a maximum electrical capacity of 540 Kw at a voltage of 36 and an amperage of 15,000. The design study shows that it is feasible to safely heat helium in the trailer mode of operation (0°F inlet temperature) to an exit temperature of 2500°F, without excessive pressure and power losses, in a heater of reasonable size. Also described is a circulator intended to provide the necessary helium flow through the experimental test loop when the facility is not being supplied from the helium trailer. The performance, construction materials, and design revisions necessary to use the circulator (which is a type used in testing nuclear reactors with helium) in the heat exchange test facility are discussed. It was determined that the circulator is inexpensive and reliable, and will provide the necessary helium flow for the test facility. L.S.

**N67-14940*#** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
**MATERIALS ANALYSIS BRANCH SOP-41. MATERIALS TESTING AND MALFUNCTION INVESTIGATION CAPABILITY**
18 Dec. 1965 39 p
(NASA-TM-X-59274; GP-225) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Capabilities of a materials analysis branch for testing and evaluation of spacecraft components is reported. Organization of the branch is described, and equipment utilized to conduct investigations is enumerated. Laboratory facilities are divided with respect to malfunction determination, materials testing, nondestructive testing, and environmental testing. S.P.

**N67-15148*#** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
**BASE SUPPORT SERVICES CONTRACTOR ROADS AND GROUNDS MAINTENANCE, VOLUME 3 Technical Manual**
1 Apr. 1966 95 p
(NASA-TM-X-59297; TM-431-TWA) CFSTI: HC $3.00/MF $1.30 CSCL 22D

The following functional responsibilities are outlined: (1) crawler-transporter refueling; (2) crawlerway surface maintenance; (3) emergency procedures for movable span bridges; (4) operating procedures for Banana River bridge; (5) inspection and testing of wire ropes, slings, and hoists; (6) waterways sounding and dredging; and (7) landscape maintenance and horticultural plan. K.W.

# 12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

**N67-14401*#** Wisconsin Univ., Madison. Mathematics Research Center.
**LECTURES IN APPLIED MATHEMATICS. VOLUME 7: SPACE MATHEMATICS, PART 3**
J. Barkley Rosser, ed. Providence, R. I., Am. Mathematical Soc. 1966 308 p refs Proc. of the 3d Summer Seminar in Appl. Math., Ithaca, N. Y., 1963
(Grant NsG-358; Contracts DA-31-124-ARO(D)-82; AT(30-1)-3164; Nonr(G)-00025-63; Grant NSF GE-2234 et al)
(NASA-CR-80874) CFSTI: HC $7.00/MF $1.50 CSCL 20D

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7. THE TWO VARIABLE EXPANSION PROCEDURE FOR THE APPROXIMATE SOLUTION OF CERTAIN NONLINEAR DIFFERENTIAL EQUATIONS J. Kevorkian (Washington Univ.) p 206–275 refs (See N67-14408 05-19)

8. RENDEZVOUS PROBLEM J. C. Houbolt (Aeron. Res. Assoc. of Princeton, Inc.) p 276–301 (See N67-14409 05-30)

N67-14402*# Cornell Univ., Ithaca, N. Y.
**BASIC FLUID DYNAMICS**
S. F. Shen *In* Wis. Univ. Lectures in Appl. Math. Vol. 7: Space Math., Pt. 3 1966 p 1–53 refs (See N67-14401 05-12) CFSTI: HC $7.00/MF $1.50

The general equations of motion are formulated with emphasis placed on the motivation and derivation of the different approximations which find applications in various practical problems. These are related particularly to bodies in flight at the higher speed ranges typical of space activities. Illustrations are given to show how the theory has been exploited in the explanation and prediction of complicated physical phenomena. N.A.S.

N67-14403*# Cornell Univ., Ithaca, N. Y.
**SHOCK WAVES IN RAREFIED GASES**
S. F. Shen *In* Wis. Univ. Lectures in Appl. Math. Vol. 7: Space Math., Pt. 3 1966 p 54–93 refs (See N67-14401 05-12) CFSTI: HC $7.00/MF $1.50

Developments in rarefied gas dynamics are surveyed with emphasis on the treatment of flow problems in terms of the observables, such as mean velocity, pressure, temperature, shear stress, and heat flux. The problem is restricted to shock wave structure, and the equations for rarefied gas dynamics are formulated. The kinetic theory of gases is used to replace the conventional Navier–Stokes and Fourier relations in the hydrodynamic equations of motion, applicable throughout the entire range of Knudsen numbers. N.S.A.

N67-14404*# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
**MODELS OF GAS FLOWS WITH CHEMICAL AND RADIATIVE EFFECTS**
F. K. Moore *In* Wis. Univ. Lectures in Appl. Math. Vol. 7: Space Math., Pt. 3 1966 p 94–152 refs (See N67-14401 05-12) CFSTI: HC $7.00/MF $1.50

Several assumptions and physical and mathematical models, useful in the analysis of hypersonic flows of a real dissociating gas, are discussed. These include: (1) lumped constituents; (2) Lighthill ideal gas; (3) nearly equal speeds of sound; (4) quasi-equilibrium radiation; (5) gray gas; (6) constant pressure and enthalpy behind normal shock; (7) Newtonian flow; (8) binary scaling; (9) coupling of vibration and dissociation; (10) sudden freezing; (11) constant entropy; (12) channel flow in stream tubes; (13) viscosity evaluation in hottest part of flow; (14) constant Pr, Le, $\rho\mu$; (15) $Q \propto \Delta H$; (16) Couette flow; (17) viscous waves; (18) thin reaction layer; and (19) a smaller equilibrium change in internal energy than in chemical energy. N.A.S.

N67-14460*# National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Tex.
**ANALYSIS OF TEST TIMES AND BOUNDARY LAYER INDUCED PROPERTY VARIATIONS IN A CIRCULAR SHOCK TUBE**
John J. Bertin Washington, NASA, Jan. 1967 26 p refs
(NASA-TN-D-3759) CFSTI: HC $1.00/MF $0.50 CSCL 20D

The flow field between the shock wave and the contact surface in a circular shock tube has been solved in the steady-state case, that is, one in which the contact surface moves at the same speed as the shock wave. Axial and radial variations in the velocity and thermodynamic properties due to the presence of a laminar boundary layer have been considered. The momentum and energy equations are solved simultaneously subject to the requirement that the mass flux across a given cross section of the tube equals the mass flux across the shock wave. Flow in the inviscid region is assumed to be an isentropic compression of real air. The computed solutions were compared with measurements reported for shock Mach numbers from 4.51 to 9.50. The theoretical results are in good agreement with the measurements of the test time, the velocity profile, and the axial distribution of density. Furthermore, the solution technique has been used to solve for the test time assuming that the boundary layer is wholly turbulent. The results indicate that boundary layer turbulence significantly reduces the test time. Author

N67-14465*# Nottingham Univ. (England).
**SOME FLOW PROPERTIES OF BLOOD**
R. L. Whitmore *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 57–71 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

A critical review is made of the literature relating to the rheological properties of blood. The regions of general agreement and disagreement are outlined and discussed in the light of present day fluid and particle mechanics. Author

N67-14472*# Mellon Inst., Pittsburgh, Pa.
**NORMAL STRESS MEASUREMENTS ON POLYMER SOLUTIONS**
Hershel Markovitz *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 189–212 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

On the basis of recent theories of continuum mechanics it has been shown that three functions of the rate of shear suffice to describe the flow of a very general incompressible fluid in a class of steady shearing motions. These flows include those which are approximated in several of the experimental methods commonly used in viscometry. One of the functions is related to the shearing stress and can be taken to be the rate of shear dependence of the viscosity. The other two deal with the normal stresses. Some experimental methods of determining the normal stress functions are discussed. Data obtained on solutions of polyisobutylene in cetane in three types of flow are presented. The data obtained at low rates of shear are discussed in terms of the theory of the second-order fluid. The functions of linear viscoelasticity are related to slow steady flow behavior. Author

N67-14473*# Brown Univ., Providence, R. I.
**SOME NON-NEWTONIAN EFFECTS IN FLOW THROUGH TUBES**
A. C. Pipkin *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 213–222 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

Rectilinear flow of nonlinear viscoelastic fluids through straight tubes can only occur if the tube is of circular cross section or if the rheological constants satisfy certain relations. The present review gives a qualitative discussion of these results and considers the matter of the normal stress distribution on the walls of the tube. The related problem of oscillating flow is discussed briefly. Author

N67-14475*# Farbenfabriken Bayer, A. G., Leverkusen (West Germany).
**SOME SECONDARY FLOW PHENOMENA IN GENERAL VISCOELASTIC FLUIDS**
Hanswalter Giesekus *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 249–266 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

The secondary flow of incompressible viscoelastic fluids around a rotating sphere as well as in a double-cone and a cone-and-plate arrangement is calculated by means of a perturbation method (second-order theory). In the first case, an additional flow component is found which enters in the equator zone and flows off at the poles, while in the second case the secondary flow in the vicinity of the inner cone is directed toward the vertex and, correspondingly, at the outer cone away from the vertex. These effects occur in suitable polymeric solutions in pronounced form.

and the shape of the streamlines coincides rather well with the results of the theory. With rising speed of rotation, effects of higher than second order increasingly come into play. At the same time, the influence of the centrifugal force will become noticeable and will finally be predominant in a certain zone surrounding the rotating bodies, whereas outside that zone the secondary flow due to viscoelasticity will continue to dominate. Similar effects are to be observed with different types of stirrers. R.U.

N67-14476*# Israel Inst. of Tech., Haifa.
**SECOND-ORDER STRESSES IN THE FLOW OF GASES**
M. Reiner *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 267–279 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

This is a review of work in which the presence of cross stresses was discovered in the laminar flow of gases. A number of instruments were built and used in which the gas was brought into torsional flow between two metal discs, a stationary stator, and a rotating rotor. Let 1 be the direction of the flow of the lamina, 2 the direction normal to the lamina, and 3 the direction normal to the 1–2 plane. It was found that in addition to the tangential stress between the laminae, a tension in the 1-direction and a pressure in the 2-direction is present. In torsional flow, the tension in the 1-direction causes a centripetal pressure in the 3-direction. In an instrument in which the rotor was free to move along its vertical axis, the pressure, generated in the gap between stator and rotor, counteracted the centrifugal forces in the rotating gas and supported the weight of the rotor. Experiments were carried out at full, two-thirds, and one-third atmospheric ambient pressure, and it was found that the effect is roughly reduced in proportion to the reduction of the ambient pressure. Experiments were also carried out with monatomic gases (Ne, A, He), diatomic gas N, and triatomic gas $CO_2$. The effect was of the same magnitude in all these cases. Author

N67-14479*# Glasgow Univ. (Scotland). Dept. of Electrical Engineering.
**VISCOELASTIC RELAXATION IN LIQUIDS AND POLYMERS**
John Lamb *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 317–344 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

Non-Newtonian viscoelastic behavior of liquids is studied by means of experimental techniques using alternating shearing stress. Measurements as a function of frequency are made over a wide range of temperature and at high pressures. An account is given of recent studies of the viscoelastic properties of lubricating fluids and of a series of polydimethyl siloxanes ranging in viscosity from 1–1000 poise. Ferry has applied the Rouse theory to account for the viscoelastic behavior of undiluted monodisperse polymer liquids. The theory has been further developed to describe the properties of polydisperse polymers in which considerable entanglement is present. Good agreement is obtained between experimental results and theoretical prediction over some seven decades of frequency. Author

N67-14513*# Rohm and Haas Co., Bristol, Pa. Research Labs.
**THE RHEOLOGY OF POLYELECTROLYTES. IV: THE DEPENDENCE OF TURBULENCE ON POLYMER CONCENTRATION**
E. Lloyd Kelley and John G. Brodnyan *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 571–582 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

The transition from laminar to turbulent flow was investigated as a function of concentration for aqueous solutions of poly (acrylic acid). It was found that the use of any solution viscosity gives a Reynolds number which decreases with increasing concentration of polymer above a critical concentration. This concentration is approximately 0.04 $g.ml.^{-1}$ for the particular poly(acrylic acid) investigated. However, if one uses the solvent viscosity, the Reynolds number increases from about 2500 to approximately 7000 and thereafter remains constant with increasing polymer concentration. It is as if the turbulence is to be associated with the solvent and its viscosity although the presence of the polymer may help to damp out minor disturbance which could lead to turbulence. Similar investigations of xylene solutions of polymers of methyl methacrylate and styrene were unsuccessful because of limitations imposed by the existence of large kinetic energy corrections and apparently large heating effects which were not observed with the poly(acrylic acid) solutions. Author

N67-14514*# Delaware Univ., Newark.
**NORMAL STRESSES IN POLYMERIC SOLUTIONS**
R. F. Ginn and A. B. Metzner *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 583–601 refs Sponsored in Part by NSF (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

Experimental measurements of the normal stresses exhibited by visco-elastic fluids in a simple laminar shearing flow field are reported. Two rheogoniometric total force techniques and the capillary jet were employed for this purpose; especial pains were taken to consider experimental aberrations carefully with a view to obtaining results more precise than those now available. The data obtained are used to assess the comparative magnitudes of the three normal stress terms; the variation of these stresses with deformation rate is compared with the charges predicted by the available constitutive equations. Author

N67-14516*# Manhattan Coll., New York.
**VELOCITY FIELD INDUCED IN A LIQUID BY A ROTATING CONE**
C. E. Miller and W. H. Hoppmann, II (Rensselaer Polytech. Inst.) *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 619–635 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00
(Contract Nonr-591(16))

An analytical study is presented of the steady-state velocity field induced in a liquid by a rotating cone. As a consequence of the experimental observations, velocity functions which very accurately define the flow have been developed. The functions are of such a nature that the centerline of a vortex and the flow about the centerline are accurately described. The boundary conditions at the surface of the rotating cone and at the fixed boundaries are satisfied. The continuity equation is also satisfied. Finally, the stress field in the fluid has been studied in terms of the velocity functions. In particular, the relation between angular velocity of cone and the total torque on the cone was determined by precise experiments. The relation is linear and a discussion of the implications of this fact in terms of the nature of the constitutive equations for the liquid is presented. The force of the evidence is that the liquids studied are Newtonian and the viscosity coefficients determined by experiment agree with those cited by various authorities. Author

N67-14526*# Cornell Univ., Ithaca, N. Y. Geer Lab. for Rubber and Plastics.
**ANALYSIS OF VARIABLE-HEAD VISCOMETER DATA**
F. Rodriguez and A. J. Berger *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 41–51 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The capillary viscometer with continuously varying pressure head gives flow data in integral form which must be differentiated in order to arrive at ordinary stress, rate of shear, diagrams. A mathematical model is postulated other than Newtonian, and the integral data are plotted in a special way. Calibration charts for several mathematical models have been prepared. The method is illustrated with data obtained on pseudo-plastic polymer solutions. The results from the varying head viscometer are compared with those determined in rotational viscometers. The only unique

mechanical feature of the viscometer used is its simplicity and low cost. This recommends it as a suitable student experiment in university courses in physical chemistry or polymer engineering. Author

**N67-14529*#** Aberdeen Proving Ground, Md.
**A FLOW-NO-FLOW CRITERION IN THE GRAVITY FLOW OF POWDERS IN CONVERGING CHANNELS**
Andrew W. Jenike and Tadeusz Leser *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 125–141 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

A powder exhibits frictional and cohesive properties and when placed in a channel does not always discharge through an orifice under the action of gravitational forces but often forms a stable dome across the channel. The dome forms when the solid develops sufficient strength to support its own weight. The strength of a solid is not constant but is a function of the pressure under which the solid has been consolidated. This function is different for each solid and measures its flowability; it is therefore referred to as the flow function of a solid. The pressure which causes consolidation is a function of the solid and of the shape and size of the channel. A flow-no-flow criterion is described which is based on the premise that for the flow to prevail the strength of the solid must be exceeded by the stresses which would act in a stable dome. Earlier work is summarized and a lower bound is proposed for the stresses in a stable dome in axial symmetry and in plane strain. Examples of design of channels for flow are given. Author

**N67-14538*#** Institut Pasteur, Paris (France). Service de Biophysique.
**CORRELATIONS BETWEEN RHEOLOGIC BEHAVIOR AND STRUCTURE CHANGES OF CONCENTRATED MICELLAR SOLUTIONS [CORRELATIONS ENTRE LE COMPORTEMENT RHEOLOGIQUE ET LES CHANGEMENTS DE STRUCTURE DES SOLUTIONS MICELLAIRES CONCENTREES]**
D. Bourgoin *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 307–320 refs In FRENCH (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

Types of structures occurring in micellar isotropic solutions at rest are discussed, and the changes in structure that are accompanied by modifications in the composition of intermicellar liquids are considered. Attention is given to changes due to variations in shearing stress, temperature, and concentration of micellar phase; and specifics are given for various types of solutions with differing concentrations. The importance of the heat of activations on rheooptical and rheological phenomena is treated, and correlations are given between these two types of properties for concentrated micellar solutions. Transl. by M.W.R.

**N67-14544*#** St. Andrews Univ. (Scotland). Dept. of Civil and Mechanical Engineering.
**THE MEASUREMENT OF A NORMAL STRESS EFFECT USING A TUBE VISCOMETER**
J. Harris *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 417–428 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

It is argued that in the flow of fluid from a tube viscometer expansion of the emerging jet can lead to the sensing of an axial force distinct from the momentum thrust. It is shown under what circumstances this axial force can be identified with an axial elastic force. The existence of this force in elastic fluids has the support of other published work using the same geometry but different techniques, and this other work is briefly reviewed here. Graphs illustrating large differences between the calculated and observed thrusts are given for a range of tubes. Finally it is pointed out that even in the absence of gravity, air friction, and other disturbances, owing to the requirement of two different surface tensions in the axial and hoop directions, the jet never reaches a true equilibrium state. Author

**N67-14545*#** New South Wales Univ., Kensington (Australia). School of Chemistry.
**SPATIAL DISTRIBUTION OF STRESSES IN SHEARING MOTION**
R. C. L. Bosworth *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 429–436 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The $P_{zz}$ component of the stress tensor was determined for a series of fluids at different rates of shear. The normal stress component was found not to be related directly to the rate of shear, but related to a function of the rate of shear and of the mean distance between the plane of the surface and the plane of the bottom of the vertical tube, in the apparatus employed. It is suggested that the cross-viscosity effect may be associated with the fact that the different strain components are not independent when the strains are large. Author

**N67-14547*#** Naval Ordnance Test Station, Pasadena, Calif.
**THE TOMS PHENOMENON IN THE TURBULENT FLOW OF VERY DILUTE POLYMER SOLUTIONS**
A. G. Fabula *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 455–479 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The turbulent pipe-flow frictional pressure drop of very dilute aqueous solutions of six homologous poly(ethylene oxides) were measured and correlated with polymer molecular weight and concentration. Pipe diameter was 1.02 cm and typical Reynolds numbers were about $10^5$. Notable results were: (1) cases of 20% friction reduction due to a 1 g./kl. concentration of polymer (of several million molecular weight); (2) evidence of increasing friction along the pipe for 400 pipe diameters after an abrupt contraction, suggesting possible scission or disentanglement of macromolecular coils; and (3) a notable correlation for the homologous polymers tested between turbulent flow properties and the size and overlap concentration of the macromolecular coils, as indicated by intrinsic viscosity. Author

**N67-14640#** Aeronautical Research Council (Gt. Brit.)
**LAMINAR BOUNDARY LAYERS WITH UNIFORM FLUID PROPERTIES. SIMILAR SOLUTIONS TO THE VELOCITY-EQUATION INVOLVING MASS TRANSFER**
H. L. Evans (Imperial Coll.) Sep. 1964 131 p refs Supersedes ARC-26180; See<X65-13388<
(ARC-CP-857; ARC-26180) CFSTI: HC $4.00/MF $1.00

The report discusses solutions to the equation:

$$f''' + ff'' + \beta(1-f'^2) = 0$$

subject to the boundary conditions $f = f_0$, $f' = 0$ at $\eta = 0$ and $f' \to 1$ as $\eta \to \infty$. Numerical solutions are tabulated for wide ranges in the pressure gradient parameter $\beta$ and mass transfer parameter $f_0$. Some related topics discussed are: (1) the asymptotic behaviour of solutions for intensive mass transfer; (2) the ranges of $\beta$ and $f_0$ for which acceptable solutions exist; and (3) the application of these "similar" solutions to problems involving non-similar flows. Author

**N67-14700#** Rutgers Univ., New Brunswick, N. J. Dept. of Mechanical Engineering.
**SOLID DENSITY DISTRIBUTION IN GAS-SOLID PIPE FLOW**
P. S. Baw and Richard L. Peskin Apr. 1966 48 p refs
(Contract AT(30-1)-2930)
(NYO-2930-6; TR-108-MF-F) CFSTI: HC $2.00/MF $0.50

The solid phase density distribution in gas-solid turbulent flow was measured by optical techniques. Density profile computations were attempted using a Reynolds averaging technique and it was

found that the mean density profile depends on the correlation of axial and transverse particle velocity. Author (NSA)

N67-14702# General Electric Co., Philadelphia, Pa. Missile and Space Div.

**LAMINAR INCOMPRESSIBLE LEADING AND TRAILING EDGE FLOWS AND THE NEAR WAKE REAR STAGNATION POINT**

S. Weinbaum May 1966 57 p refs Presented at the AGARD Specialists Meeting on "Separated Flows" at the von Karman Inst. for Fluid Dyn., Rhode-Saint-Genese, Belg., 10 May 1966 Supersedes R66SD18

(Contract AF 04(694)-897)

(R66SD25; R66SD18; AD-632542) CFSTI: HC $3.00/MF $0.75

The paper investigates the behavior of a viscous incompressible fluid in the vicinity of various two-dimensional separation and stagnation points. Locally valid series solutions to the Navier–Stokes vorticity equation are developed to study the pressure-viscous force balance in the neighborhood of the singularity and the transition to the flow region where inertial effects are important. Solutions are presented for an arbitrary symmetric leading or trailing edge except for an arbitrary constant that depends on the wall shear. The solution for the near wake rear stagnation point shows that the wake cannot close in an arbitrary manner, but that the asymptotic direction of the dividing streamline prior to stagnation is a single valued function of the ratio of the velocity on the dividing streamline to that on the wake centerline. The blunt based trailing edge is examined from two viewpoints. One is analogous to Goldstein's development for the flat plate trailing edge in that it assumes a Blasius profile at separation. The other is a parametric study to explore the effect of upstream influence on the point of separation and the initial shape of the dividing streamline. Author (TAB)

N67-14905*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

**EXPERIMENTAL INVESTIGATIONS OF WEDGE BASE PRESSURE AND LIP SHOCK**

Francis R. Hama 1 Dec. 1966 56 p refs

(Contract NAS7-100)

(NASA-CR-81031; JPL-TR-32-1033) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Base-pressure and surface-pressure measurements together with schlieren and shadowgraph observations were conducted on 6-deg half-angle wedges of various separation-edge shapes. The lip shock, which emanates from even a sharp separation edge, was found to be of substantial strength, contrary to the prevailing belief. In most cases investigated here, predominant cause of the lip shock appears to be the viscous separation effect similar to that of the separation shock emanating from a circular cylinder, rather than the inviscid rotational effect. Author

N67-14952# Aeronautical Research Council (Gt. Brit.)

**ON THE PRESSURE DISTRIBUTION BEHIND THE REFLECTED DIFFRACTED SHOCK**

R. S. Srivastava (Defence Sci. Lab., Delhi) 15 Jun. 1965 11 p refs

(ARC-27036; FM-3612; AD-642183) CFSTI: HC $3.00/MF $0.65

The pressure distribution has been obtained along the wall behind the reflected diffracted shock for finite incident shock strength on the basis of the theory developed in 'Diffraction of Blast Wave for the Oblique Case' by R.S. Srivastava.

Author (TAB)

N67-14967# Office of Naval Intelligence, Washington, D. C. Translations Section.

**A CONVERGENT SHOCK WAVE IN A HEAT CONDUCTING GAS [SKHODYASHCHAYASYA UDARNAYA VOLNA V TEPLOPROVODNOM GAZE]**

Ye. I. Zababakhin and V. A. Simonenko [1966] 7 p refs Transl. into ENGLISH from Prikl. Mat. i Mekh. (Moscow), v. 29, 1965 p 334–336

(ONI-TRANS-2084; TT-66-62468; AD-640626) CFSTI: HC $1.00/MF $0.50

The focusing of a convergent spherical wave was analyzed for the case that only enough power was generated to produce a balance of radiation and matter at all points in which the width of the heat zone was large in comparison to the range of radiation; considered was only the wave's early stage when its width was smaller than its radius. It was shown that heat conductivity eroded the wave front so that a zone of heat and gas movement formed ahead of the advancing consolidation, and mofidied the unlimited cumulation; in place of a limited density and an unlimited temperature an ultimate temperature and an infinite density was found. G.G.

N67-14972# Aeronautical Research Council (Gt. Brit.) Propulsion Aerodynamics Sub-Committee.

**POTENTIAL FLOW THEORY FOR TANDEM CASCADE BY HOWELL'S METHOD**

Y. M. Yip and J. W. Railly (Birmingham Univ.) 3 Dec. 1965 52 p refs Sponsored by Army

(RR-56; ARC-27510; AD-642180) CFSTI: HC $3.00/MF $0.65

The solution of a tandem cascade is obtained by replacing the second blade by singularities (two in this case), and carrying out an exact conformal transformation of the first blade by Howell's method. A digital computer programme which deals with the numerical work of the final Karman–Theodorsen transformation in a new way is described. Author (TAB)

N67-14979# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.

**AN EXPERIMENTAL INVESTIGATION OF THE GENERATION OF WATER WAVES BY AIR SHEAR FLOWS**

Ashok Kumar Gupta Jun. 1966 142 p refs

(Contract Nonr-1841(89))

(ASRL-TR-116-3; AD-638728) CFSTI: HC $4.00/MF $1.00

A tank of length 46 in., width 12 in., and depth 5 1/4 in., tipped with a 4 1/2 in., long aluminum plate was filled with ordinary tap water and was placed parallel with a uniform air stream of low turbulence. Visual observations of the water free surface were made in the air speed range of 2 FPS to 26 FPS. (1) Allowing for the effects of slightly accelerating air flow and the finite length of the tank, the measured mean velocity profiles of the laminar air boundary layer agree in all essential aspects with Lock's velocity profile computed for zero pressure gradient. (2) Water wave generation by wind with laminar boundary layers consists of two phenomena: maintenance of water wave and initiation of water wave. A relatively low air speed can maintain a relatively long water wave but cannot initiate it. For the laminar boundary layer water waves of wavelengths 2 to 3 cm first appear at air speeds of 530 to 595 cm/sec. For the turbulent boundary layer the water waves first appear at air speeds of 350-400 cm/sec. (3) For air speeds greater than 23 FPS with the boundary layer laminar a Kel. Helm. type instability seems to occur. (4) Customary plots of neutral oscillations of Tollmien Schlichting waves modified by the water surface made for air speeds of 11.3, 17.5 and 20.6 FPS suggest a destabilising effect of the water surface. TAB

N67-15001# Ballistic Research Labs., Aberdeen Proving Ground, Md.

**NOTE ON SHOCK REFLECTION COEFFICIENT**

Nathan Gerber Aug. 1966 15 p refs

(BRL-MR-1775; AD-642091) CFSTI: HC $3.00/MF $0.65

The shock reflection coefficient, $R_w$ is defined here as the ratio of pressure drop across a reflected disturbance from a shock wave to that across the incident disturbance wave (which is generated downstream of the shock). The treatment of shock reflection coefficients in the work of previous investigators is

reviewed briefly. A derivation is given of a general expression for $R_w$ in terms of shock curvature for nonequilibrium axisymmetric flow. Sample computations show the effects of nonequilibrium flow and three-dimensionality on the behavior of $R_w$. It is shown that $R_w$ can become infinite in these situations, although for two-dimensional ideal gas flow its magnitude is always finite and usually very small. Author (TAB)

N67-15009# Aeronautical Research Council (Gt. Brit.)
**THE STEADY LAMINAR INCOMPRESSIBLE BOUNDARY LAYER PROBLEM AS IN INTEGRAL EQUATION IN CROCCO VARIABLES: INVESTIGATIONS OF THE SIMILARITY FLOWS**
R. D. Mills (Strathclyde Univ.) 22 Jun. 1966 25 p refs
(ARC-28116; AD-642184) CFSTI: HC $3.00/MF $0.65

The steady flow incompressible laminar boundary layer problem is posed as an integral equation in crocco variables in the most general case. Numerical investigations are then made of the 'similarity' flows. A transformation is utilised which weakens the singularity at the outer edge of the boundary layer and thereby gives improved numerical results over those obtained from the untransformed equation. An extensive numerical comparison is made with Polhausen's exact analytical solution. Results are also presented in graphical form illustrating the approach of the boundary layer characteristics to their asymptotic values for strong suction for a very wide range of similarity flows. These are in complete agreement with the results obtained by other investigators, and form an extension to the cases previously considered. Author (TAB)

N67-15039# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
**AN EXPERIMENTAL INVESTIGATION OF THE VISCOUS SUBLAYER IN TURBULENT PIPE FLOW**
Henry Palmer Bakewell, Jr. Sep. 1966 183 p refs
(Grant Nonr(G)-00043-65)
(AD-639804) CFSTI: HC $5.00/MF $1.00

The boundary layer research facility utilizing glycerine with its high viscosity was constructed to permit detailed experimental investigation of the viscous sublayer. In this facility at a pipe Reynolds number of 8700 the sublayer thickness was 0.110 in. which is sufficiently thick to allow detailed investigation in a region that occupies the innermost few thousandths of an inch in most typical air and water flows. Detailed measurements of the streamwise fluctuating velocities with hot-film anemometers were obtained within the viscous sublayer as well as in the transition region between the linear and logarithmic mean velocity profiles. These data were used to form the space-time correlation function of the streamwise fluctuating velocities. From these data an eigen-function expansion of the streamwise fluctuating velocity was obtained which was used to infer the dominant large scale structure of the flow in the wall region. Author (TAB)

N67-15040# North Star Research and Development Inst., Minneapolis, Minn.
**DEVELOPMENT OF A FLUID CONCENTRATED DISPERSION OF A WATER-SOLUBLE POLYMER CAPABLE OF REDUCING THE FRICTION OF WATER UNDER TURBULENT CONDITIONS Final Report, Jun. 1965–Aug. 1966**
Ralph E. Forester and Peter S. Francis 29 Jul. 1966 24 p
(Contract Nonr-4827(00))
(AD-639805) CFSTI: HC $1.00/MF $0.50

A method of using water soluble polymers to reduce the friction caused by turbulent flow of water was investigated by employing fluid, concentrated dispersions (slurries) of polymer in nonsolvent carriers. Prototype 10-percent slurries of various drag reducing polymers were injected into flowing turbulent water streams, and friction reductions as great as 49 percent were noted with mixing times as short as 1.5 seconds. Higher friction reduction was achieved at somewhat longer times. The system appears to be a very promising approach to applying drag reducing polymers to the waters around a ship hull. Author (TAB)

N67-15045# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ON THE ENTRAINED MASS OF A SUPERSONIC JET IN OFF-DESIGN SYSTEMS**
B. A. Balanin 25 Apr. 1966 12 p refs Transl. into ENGLISH from Inzh.-Fiz. Zh. (Minsk), v. 8, no. 5, 1965 p 574–578
(FTD-TT-65-1719; TT-66-62449; AD-640325) CFSTI: HC $1.00/MF $0.50

The results are presented of experimental determination of the entrained mass of a supersonic jet in off-design systems of discharge. There is given an empirical formula which connects the entrained mass of the original area of the supersonic jet in off-design modes of out-flow with the number M sub a at the cut of the nozzle, with the off-design degree, and with the distance from the nozzle cut to the section under consideration. Author (TAB)

N67-15084# Massachusetts Inst. of Tech., Cambridge. Dept. of Naval Architecture and Marine Engineering.
**THE HYDRODYNAMIC FORCES AND PRESSURE DISTRIBUTIONS FOR AN OSCILLATING SPHERE IN A FLUID OF FINITE DEPTH**
Shen Weng Jun. 1966 102 p refs
(Contract Nonr-3963(01))
(AD-640393) CFSTI: HC $4.00/MF $0.75

The fluid motion due to a semi-submerged sphere making small vertical oscillations in the free surface of a fluid of finite uniform depth is discussed. The fluid is considered incompressible and non-viscous, and the problem is formulated as a boundary value problem in linear potential theory. The velocity potential is obtained by means of a superposition of a series of singularities, placed within the sphere, in such a manner that all boundary conditions are satisfied. The exact solution contains an infinite series whose coefficients are given by an infinite set of linear simultaneous equations. Since the series converge rapidly, practical computation with a truncated set is possible. In terms of the same expansion coefficients, expressions are also obtained for the hydrodynamic forces as well as the pressure distributions on both the sphere surface and bottom boundary. Numerical calculations of the added mass coefficient, damping parameter and pressure distributions were determined for various fluid depths over a significant frequency range. The results are presented and compared with results of the infinite depth case. The results of the analysis of the influence of the lower boundary at finite depth may be interpreted in terms of the change in surface wavelength, which is a function of the frequency of oscillation and the fluid depth. Author (TAB)

N67-15090# Hebrew Univ., Jerusalem (Israel). Microwave Div.
**EFFECTS OF CROSS-SECTIONAL AREA CHANGE ON THE SPEED OF A SHOCK WAVE**
M. Dvir, W. Low, S. Maniv, and J. Stricker Apr. 1966 43 p refs
(Contract AF 61(052)-846)
(AFOSR-66-2602; SR-2; AD-642124) CFSTI: HC $3.00/MF $0.65

An experimental study of the effect of convergent and divergent nozzles with area changes of 4:1, 1:4 and 1:8 on the moderate shock speed is presented. The results are compared with the theoretical predictions of the linear and steady state theories. When the experimental values are corrected for viscous effects, it is found that near the exit of the nozzle the Mach speed approximates the values of the linear theory. Far downstream the Mach speed approaches to the steady state values. Superimposed on this gradual change are maxima and minima in the Mach speed. These fluctuations are functions of $P_4$, $P_1$, M and the angle of the taper section. These maxima and minima can be explained to arise from interference effects between the transmitted and re-reflected shock waves. Author (TAB)

N67-15093# ARO, Inc., Arnold Air Force Station, Tenn.
**CONSTANT ACCELERATION FLOWS AND APPLICATIONS TO HIGH-SPEED GUNS**
J. Lukasiewicz Arnold Eng. Develop. Center, Nov. 1966 54 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-66-181; AD-642333) CFSTI: HC $3.00/MF $0.65

Solutions for isothermal, isentropic, and constant Mach number (at a specified location) flows with constant acceleration are obtained. It is shown that in application to high-speed guns, these solutions necessitate variable gun geometry or heating of the propellant; both requirements are considered at present impractical. Numerical solutions which give constant projectile acceleration in a fixed geometry gun are computed for ideal and real hydrogen propellant, using the later, and the appropriate similarity parameters, as well as practical constraints related to gun and projectile geometry and strength, it is shown that a substantial increase in muzzle velocity could be obtained if the constant base pressure cycle were more closely approximated in actual launchings. At present the velocity attained with large caliber guns is much smaller than with the small ones. In this connection, the validity of linear scaling of guns and the resulting possibility of application of small-scale developments to large caliber guns are indicated. Author (TAB)

N67-15106# Aeronautical Research Council (Gt. Brit.)
**MEASUREMENTS OF ENTRAINMENT BY A FREE ROTATING DISC**
P. Case Jun. 1966 14 p refs
(ARC-27997; AD-642182) CFSTI: HC $3.00/MF $0.65

Measurements are presented of the amount of air which flows axially towards the surface of a disc rotating at various speeds when the nature of flow is turbulent. The area to one side of the disc is surrounded by a chamber, leaving a small gap between the chamber and the disc. Air is injected into this via a porous baffle until the pressure in the chamber is uniform and atmospheric, a condition which is taken to signify that the 'entrainment appetite' of the disc is satisfied. Existing theories predict the results obtained well at high disc Reynolds numbers, but give greater entrainment rates than experiment at low disc Reynolds numbers. More precise measurements are needed to substantiate these conclusions: in particular the use of a hot-wire anemometer seems essential. Author (TAB)

N67-15115# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
**METHOD OF CHARACTERISTICS FOR CALCULATING THREE-DIMENSIONAL SUPERSONIC GAS FLOWS**
Yu. N. Podladchikov 19 Oct. 1966 24 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Mekhan. (USSR), no. 4, 1965 p 3-12
(Contract NOw-62-0604-c)
(TG-230-T506; TT-67-60040; AD-642626) CFSTI: HC $3.00/MF $0.65

The method of characteristics (extended from two to three independent variables) is used to solve the problem of supersonic flow of an ideal gas over a blunt body. The steady motion of the gas is described by a system of partial differential equations. A cartesian coordinate system is fixed to the flow. A scheme based on the relations on the characteristic planes is proposed for calculating the supersonic portion of the flow, and therefore the calculation of a point depends on whether it is found in the shock wave, in the flow field, or on the surface of the body. The computational procedures for these three cases are outlined and illustrated by examples. Author (TAB)

N67-15176# Joint Publications Research Service, Washington, D. C.
**THROTTLING ELEMENTS IN A FLOW OF COMPRESSIBLE GAS**
O. V. Lyzhin 12 Jan. 1967 13 p Transl. into ENGLISH from Inzh. Zh. (Moscow), v. 5, no. 4, 1965 p 641-649
(JPRS-39495; TT-67-30145)

A throttle for regulating the flow of a compressible gas was studied in the light of gas dynamics laws. Relationships are obtained for the resistance between the throttle and the characteristic flow number. The study also deals with the throttle characteristics which are favorable for executing the transition processes and for maintaining constant pressure. The design for a ring-aperture type of throttle, suitable for the regulation of a large volume of gas, is also obtained. A theoretical method for computing the characteristics for this type of throttle is given along with experimental confirmation. C.T.C.

N67-15214*# National Bureau of Standards, Boulder, Colo.
**THE VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS OF DILUTE NITROGEN AND OXYGEN**
G. E. Childs and H. J. M. Hanley 31 Oct. 1966 33 p refs
(NASA Order R-08-006-046)
(NASA-CR-81126; NBS-TN-350) GPO: HC $0.25; CFSTI: MF $0.65 CSCL 20D

The coefficients of viscosity and thermal conductivity for dilute nitrogen and oxygen were examined using a method proved suitable for argon. Given the kinetic theory expressions for the transport coefficients, this method indicates a selection of a potential function and its parameters to correlate theory with experimental data. It was found that the Kihara was most suitable and theoretical viscosity coefficients were computed with this function. The usual correction to the kinetic theory equation for thermal conductivity, the Eucken correction, was found not to be sufficient and it was decided to use an empirical polynomial equation to correlate the thermal conductivity coefficients. Tables of the transport coefficients for both gases are given between 100 and 1000°K. Author

N67-15249*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
**ANALYTICAL INVESTIGATION OF TURBINE EROSION PHENOMENA. VOLUME II: FLUID, DYNAMIC AND THERMODYNAMIC PROCESSES INVOLVED IN TURBINE BLADE EROSION Interim Technical Report**
R. E. Kothman, W. K. Fentress, W. D. Pouchot, and J. D. Milton 1 Nov. 1966 168 p refs
(Contract NAS7-390)
(NASA-CR-81139; WANL-PR-(DD)-014, Vol. II; ITR-1, Vol. II) CFSTI: HC $3.00/MF $2.60 CSCL 20D

This report presents analytical models of the various fluid dynamic and thermodynamic processes involved in turbine blade erosion. The general categories of processes examined are condensation, bulk and boundary layer flows and deposition of condensate, and atomization and subsequent trajectories of damaging liquid. Using the analytical models selected, two wet vapor turbines are examined, and results of the calculations are reported. The turbines investigated are analytical simulations of the low pressure steam turbine of the Yankee Atomic Power Plant, and the General Electric two-stage potassium test turbine. Estimated results are in qualitative agreement with experimental observations. Available quantitative experimental data is too sparse to allow definite conclusions to be drawn. The process models selected appear to be adequate for at least order of magnitude turbine erosion estimation usage and provide a basis for further refinement. Author

N67-15257*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
**ANALYTICAL INVESTIGATION OF TURBINE EROSION PHENOMENA. VOLUME I: ASSEMBLY OF ANALYTICAL MODEL OF WET VAPOR TURBINE BLADE EROSION Interim Technical Report**

W. D. Pouchot, R. E. Kothman, W. R. Fentress, F. J. Heyman, J. D. Milton et al 1 Nov. 1966 83 p refs
(Contract NAS7-390)
(NASA-CR-81135, WANL-PR-(DD)-014) Vol. 1; ITR-1, Vol. I) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The construction and application of an analytical model of turbine rotor blade erosion in wet vapor turbines are described. The model is used to estimate erosion values for the analytical simulations of a nine-stage wet vapor steam turbine and a two-stage wet vapor potassium turbine. Comparison of operating results from the actual turbines with the calculated values gives a substantial degree of quantitative agreement. While the present degree of quantitative agreement may in part be fortuitous, the model selected appears to be adequate for at least order of magnitude turbine erosion estimation and provides an excellent base for refinement. Author

**N67-15258*#** Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
**ANALYTICAL INVESTIGATION OF TURBINE EROSION PHENOMENA. VOLUME III: EFFECT OF EXTERNAL VARIABLES ON THE EROSION PROPERTY OF MATERIALS Interim Technical Report**
F. J. Heymann and F. R. Arcella 1 Nov. 1966 34 p refs
(Contract NASA-390)
(NASA-CR-81136; WANL-PR-(DD)-014, Vol. III; ITR-1, Vol. III) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The literature on impingement erosion has been examined with a view to deducing empiric (or analytic) relationships for the relationships between erosion rate and external variables, in particular the velocity, angle of impingement, and size and shape of the impacting drops. The difficulties inherent in the interpretation of erosion test data are discussed and a rationalized approach is described. The available data yield only very approximate generalizations, which should be subjected to further experimental trial. One of the major difficulties in the correlation of test data is the variation of erosion rate during a test. An analytic model is proposed to explain this variation. Except for short discussion on dissolution of materials by liquid metals, this report is concerned with the effect of external conditions such as impact velocity, etc., on the erosion of metals by the impingement of liquid drops. Author

**N67-15288#** Naval Ordnance Lab., White Oak, Md.
**PRESSURE VARIATIONS INSIDE A GAS-FILLED ENCLOSURE DUE TO CAPILLARY FLOW**
Henry Gerber 3 May 1966 20 p refs
(NOLTR-66-115; AD-640010) CFSTI: HC $1.00/MF $0.50

The report presents methods for computing the effect of capillary flow on the pressure and temperature of confined gases. Formulas for computing the gas velocity in the capillary tube are also given. Author (TAB)

**N67-15338#** Aeronautical Research Council (Gt. Brit.)
**A TWO-PARAMETER METHOD FOR CALCULATING THE TWO-DIMENSIONAL INCOMPRESSIBLE LAMINAR BOUNDARY LAYER**
N. Curle (Southampton Univ.) 21 Jun. 1966 38 p refs
(ARC-28113; FM-3718; AD-6421d5) CFSTI: HC $3.00/MF $0.65

Careful examination of the available range of exact solutions of the boundary layer equations has enabled the four functions $F_0$, $F_1$, $G_0$, $G_1$ to be tabulated, and the above functional forms agree with the exact solutions to a quite remarkable accuracy. Author (TAB)

# 13 GEOPHYSICS

**Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.**

**N67-14367#** Joint Publications Research Service, Washington, D. C.
**TRANSLATIONS FROM TI-LI CHI-K'AN, NUMBER 5, MAY 1963**
5 Dec. 1966 206 p refs Transl. into ENGLISH from Ti-Li Chi-k'an (Peking), no. 5, May 1963 p 1–120
(JPRS-38942; TT-66-35365) CFSTI: $5.00

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**N67-14368#** Joint Publications Research Service, Washington, D. C.
**A STUDY OF THE PHYSIOGRAPHICAL FORMATION OF WESTERN SZECHUAN AND WESTERN YUNNAN**
Lai-Hsing Lo and I-Ch'ou Chang *In its* Transl. from Ti-Li Chi-K'an, No. 5, May 1963 5 Dec. 1966 p 1–86 (See N67-14367 05-13) CFSTI: $5.00

A physiographical survey is presented of the general region of Western Szechuan and Northern Yunnan, which lies in the southeastern part of the Tsinghai-Tibetan Plateau and consists mainly of mountainous plateaus and canyons. The general topographical features of the region are described and an analysis made of fault basins and grabens, shallow and deep valleys, ancient peneplains, and traces of ancient glaciation. On the strength of this analysis, the physiographical development of the region is shown to fall into three stages. Stage one, between the lower Paleocene and upper Miocene epochs, is a period of the formation of uniform peneplains. Stage two, between lower Pliocene and upper Pleistocene or even later, is a period of the disintegration of the uniform peneplains. Stage three, between the lower Pleistocene or even earlier and the present, is a stage of the interactions of glaciers and streams. The survey concludes that the uplifting and warping of the peneplains between the Pliocene and Pleistocene epochs were chiefly responsible for the physiographical formation of the region. R.N.A.

**N67-14369#** Joint Publications Research Service, Washington, D. C.
**A PRELIMINARY STUDY OF THE PROBLEMS OF THE DYNAMIC CHANGING PROCESS OF SAND DUNES UNDER THE PRESENCE OF WIND**
Chen-Ta Chu *In its* Transl. from Ti-Li Chi-K'an, No. 5, May 1963 5 Dec. 1966 p 87–125 refs (See N67-14367 05-13) CFSTI: $5.00

An analysis was conducted on the dynamic and changing processes of crescent shaped sand dunes under barren and flat

ground surface conditions in the presence of wind. The area of P'i Shan in the southwest part of the Takla Makan Desert was selected. Descriptions of the area and work methods used are given. The effects of variations in erosion and the accumulation of sand on the dune surface as well as wind direction on the morphological development and migration processes of the sand dune are discussed. The analysis shows that the migration of sand dunes is the result of the blowing up of sand particles on the windward slopes and the accumulation of sand particles on the leeward slopes under the action of the wind. The erosion and accumulation of sand on the dune's surface varies for each wind storm. This difference is determined by both the speed and sand content of the wind. The morphology of a sand dune is the result of the interaction of the prevailing wind and wind of other secondary directions. The morphological changes in a dune are gradual. Under barren and flat ground conditions, sand dunes migrate very fast; in the region studied it is generally 40 to 80 meters per year. R.N.A.

**N67-14370#** Joint Publications Research Service, Washington, D. C.
**THE BASIC CHARACTERISTICS OF KU-ERH-PAN-T'UNG-KU-T'E DESERT OF DZUNGARIA**
Chih-P'ing Ch'en *In its* Transl. from Ti-Li Chi-K'an, No. 5, May 1963 5 Dec. 1966 p 126–146 refs (See N67-14367 05-13) CFSTI: $5.00

Results are presented of a field survey and laboratory analysis of aerial photographs of the Ku-erh-pan-t'ung-ku-t'e Desert, which is located in the central part of the Dzungaria Basin. Previous research studies on deserts are reviewed, and the major natural factors involved in the formation of a desert are discussed. The major characteristis of the Ku-erh-pan-t'ung-ku-t'e Desert are described along with discussions of the source of sand for its sand dunes and the formation of sand hills. Some general conclusions concerning the basic characteristics of the desert are summarized. R.N.A.

**N67-14371#** Joint Publications Research Service, Washington, D. C.
**SAND TOPOGRAPHY OF K'A-SHIH INLAND DELTA OF TARIM BASIN**
Chu-Chang Li *In its* Transl. from Ti-Li Chi-K'an, No. 5, May 1963 5 Dec. 1966 p 147–160 (See N67-14367 05-13) CFSTI: $5.00

A study was made of the geology and topography of the K'a-shih inland delta of the Tarim Basin which is being threatened by wind blown sand. The study shows that although sand dunes may be developed from fluvial inland delta deposits, the morphology and characteristics of the dunes may be entirely different due to the effects of wind, terrain, moisture, vegetation, and availability of sand. The formation of sand is dependent on the percentage of the small particle grade present in the sand source material. The compactness of the surface substance and the size of the wind force determine whether or not the sand particles can be blown by the wind. Vegetation reduces the ground surface wind speed, and its roots and litter may cause the ground surface to become compact. Regarding sand control, both biological and mechanical measures such as forestation and barriers can eliminate the existing sand source and prevent the creation of a new sand source. R.N.A.

**N67-14372#** Joint Publications Research Service, Washington, D. C.
**BASIC CHARACTERISTICS, FORMATION, AND DEVELOPMENT OF THE LAKE BASIN TOPOGRAPHY OF TSINGHAI HU**
*In its* Transl. from Ti-li Chi'K'an, No. 5, May 1963 5 Dec. 1966 p 161–197 refs (See N67-14367 05-13) CFSTI: $5.00

The topographical outline of the Tsinghai Hu Basin and the direction of the mountain ranges and river valley are controlled by structural lines in the east–west and south–north directions. The surrounding mountains were formed during the Yen-shan movement at the end of the Cretaceous period. Since the Quaternary period, the foundation of the entire lake basin has been uplifted to cause a great height difference between the ground surface of this area and its surrounding regions. The new structural movement in the lake basin interior consists of relatively weak warping, twisting, arching, and uplifting. The northern half of the lake was developed on the basis of an erosion-fault lowland. The southern half was formed by the fault subsidence of the earth's crust in the new structural movement. The high mountains surrounding the lake basin were glaciated during the Quaternary period. The formation of the rocky tableland to the north was not related to glaciers. Tsinghai Hu was once expanded to the vicinity of T'ien-chun. The lake's area was one and a half times the current area and its waters were once linked with the Yellow River and Huang-shui. The lake surface is falling rapidly. R.N.A.

**N67-14380#** St. Louis Univ., Mo. Dept. of Geophysics and Geophysical Engineering.
**[TECHNOLOGICAL PROGRESS IN SEISMOLOGY, CRYSTAL MOTION, WAVE PROPAGATION AND RELATED TOPICS] Annual Technical Report**
1 Sep. 1966 24 p refs
(Contract AF 19(628)-5100; ARPA Order 292)
(AD-640637) CFSTI: HC $1.00/MF $0.50

During the course of the year the principal technical accomplishments have included efforts in the following areas: the focal mechanism of earthquakes, model studies of explosion generated waves, azimuthal departure of P wave motion from the great circle path, determination of the depth of focus, and the phase velocity of surface waves. Each of these studies is reported. Other supporting work, not reported in the present work, has been the operation of a quadrilateral long-period seismic array and the installation of a small aperture, three element bore-hole seismometer array in southeast Missouri. Author (TAB)

**N67-14504*#** Rensselaer Polytechnic Inst., Troy, N. Y.
**THE VISCOELASTIC COMPRESSION OF SOIL–WATER SYSTEMS**
Robert L. Schiffman (MIT) *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 397–422 refs Sponsored in part by NSF (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

This paper reviews the theory of consolidation and derivative theories of secondary consolidation from a rheological view. The theories of soil compression are discussed in terms of the behavior of phase elements and the coupling mechanism of the phase elements. Theories of structure of clay–water systems are discussed in terms of their influence on the compression process. Various theories of secondary consolidation are reviewed in terms of soil structure and experimental evidence. Author

**N67-14841*#** Illinois Univ., Urbana. Aeronomy Lab.
**RESEARCH IN AERONOMY. Semiannual Progress Report, 1 Oct. 1965–31 Mar. 1966**
T. W. Knecht, ed. 31 Mar. 1966 150 p refs
(Grant NsG-511; Contract AF 19(628)-3900; Grants NSF GA-374; NSF GP-866; NSF GP-2910 et al)
(NASA-CR-80855; PR-66-1) CFSTI: HC $4.00/MF $1.00 CSCL 04A

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**N67-14642*#** Illinois Univ., Urbana. Aeronomy Lab.
**DIRECT MEASUREMENTS OF ELECTRON AND ION DENSITY**
S. A. Bowhill et al *In its* Res. in Aeronomy 31 Mar. 1966 p 1–12 refs (See N67-14641 05-13) CFSTI: HC $4.00/MF $1.00

Rocket experiments in connection with IQSY measurements, as well as theoretical investigations of ion collection and their relation to ionospheric measurements are reported. Equations governing the behavior of a collision-dominated spherical probe in the steady state were written using the theory of statistical mechanics. Solutions were made for these highly nonlinear equations by performing a numerical integration of the probe surface on the electrostatic potential; and the final result is the potential on the probe. Preliminary results indicate that for probe potentials up to approximately 20 kT$_e$/e, solutions can be obtained for ion number densities between $10^3$ and $10^4$ per $cm^3$. M.W.R.

**N67-14643*#** Illinois Univ., Urbana. Aeronomy Lab.
**VERTICAL INCIDENCE ABSORPTION MEASUREMENT**
G. W. Henry, Jr. et al *In its* Res. in Aeronomy 31 Mar. 1966 p 13–30 (See N67-14641 05-13) CFSTI: HC $4.00/MF $1.00

Design, construction, and maintenance of instrumentation for use in vertical incidence ionospheric sounding are discussed, including testing of the automatic absorption recording system. Preliminary observations of ionospheric absorption, drift, partial reflections, and noise levels were begun. Ionospheric measurements by vertical incidence sounding made at Wallops Island, Virginia, during the winter of 1965–1966 are reported. Observations were begun five days prior to December launching of a rocket equipped with a payload suitable for deriving electron density and collision frequency profiles in the lower ionosphere. Since ground-based measurements showed that the launch day was not of the anomalous type, a second rocket was launched in January at about the same solar zenith angle as that of the earlier shot. This showed more than tenfold enhancement in electron density at altitudes close to 82 km, and justified the enhanced attenuation measured by the ground station. Ionospheric sounding measurements made in Illinois are also reported, as are those made aboard the USNS Croatan during the NASA mobile launch expedition. M.W.R.

**N67-14644*#** Illinois Univ., Urbana. Aeronomy Lab.
**ROCKET PROPAGATION EXPERIMENT**
S. A. Bowhill et al *In its* Res. in Aeronomy 31 Mar. 1966 p 31–95 refs (See N67-14641 05-13) CFSTI: HC $4.00/MF $1.00

Electron densities and collision frequencies obtained during Nike–Apache rocket firings are reported, along with the electron temperatures in the D and lower E regions that resulted from the collision frequency experiments. The 1966 total eclipse experiment in South America is discussed, and the eclipse survey sites in Brazil and Argentina are described. Equatorial experiments from a Nike–Apache fired at geomagnetic equator during the NASA mobile launch expedition are also reported. A section on instrumentation design covers an 8 MHz exciter, a hybrid polarizer, a pulsed radio frequency generator, antennas, and a dual phase detector used in the rocket propagation experiment launchings. M.W.R.

**N67-14645*#** Illinois Univ., Urbana. Aeronomy Lab.
**VLF STUDIES**
C. F. Sechrist, Jr. and R. A. Smirl *In its* Res. in Aeronomy 31 Mar. 1966 p 96–97 (See N67-14641 05-13) CFSTI: HC $4.00/MF $1.00

Progress is reported for studies relating to very low frequency theory and full-wave solutions of the coupled wave equations, as well as for the design and instrumentation of a VLF experiment. The latter will measure the component in the sky wave that has an electric vector perpendicular to the plane of incidence. M.W.R.

**N67-14646*#** Illinois Univ., Urbana. Aeronomy Lab.
**AERONOMIC THEORY**
J. E. C. Gliddon et al *In its* Res. in Aeronomy 31 Mar. 1966 p 98–108 refs (See N67-14641 05-13) CFSTI: HC $4.00/MF $1.00

Thermal and ionization economy of the ionosphere, ion distribution in the F region, and various theoretical and experimental studies for the development and refinement of D-region theory are reported. The latter includes pre-sunrise ionization in the D region, disturbances of stratospheric and mesospheric circulation during winter days of high absorption, a theory of the formation of a sporadic D layer in middle latitudes in winter, and the winter anomaly in ionospheric absorption. Measurements of the winter ionosphere at 3030 kHz showed a dependence of the noon vertical absorption on the altitude from which the echo return was taking place; and the period and amplitude of fading of the received echo were found to be different when the echo was received from a sporadic E layer rather than from a regular ionospheric layer. The rocket launched under the anomalous conditions showed large increases in electron density over the normal day profile at about 82 km, which persisted to a certain extent up to an altitude of about 92 km. M.W.R.

**N67-14647*#** Illinois Univ., Urbana. Aeronomy Lab.
**CROSS MODULATION**
J. S. Shirke *In its* Res. in Aeronomy 31 Mar. 1966 p 109–112 (See N67-14641 05-13) CFSTI: HC $4.00/MF $1.00

A ground based transmitter provided disturbance and the antenna directivity covered the rocket trajectory in an experiment to determine the collision frequency profile of electrons in the ionosphere. By comparing these data with those obtained from other experiments in the same rocket payload, cross modulation effects in the ionosphere were studied. Preliminary calculations indicate that a second harmonic of the modulating frequency of the disturbing transmitter could be expected in the output as a component inherent in the cross modulation phenomena. The amplitude of this second harmonic is about 1/4 that of the fundamental, and corresponds to a collisional frequency of $10^7$ electrons/sec. At $10^5$ electrons/sec, this ratio would decrease to 1/10. These calculations, which neglect effects due to the earth's magnetic field, are considered hard to understand since the output around 310 Hz appears to be a consequence of the cross modulation effect. M.W.R.

**N67-14649*#** Illinois Univ., Urbana. Aeronomy Lab.
**IONOSPHERIC DRIFTS**
G. L. N. Rao et al *In its* Res. in Aeronomy 31 Mar. 1966 p 125–133 refs (See N67-14641 05-13) CFSTI: HC $4.00/MF $1.00

Horizontal drifts in the lower and upper ionosphere were studied on a world-wide scale, and a program for measurement of these ionospheric drifts has evolved. This will include investigations of the height gradient $E_s$ drift, F2 region drifts, and winds in the D region. Preliminary design of a system for measuring these drifts makes use of instrumentation already constructed for use on the shipboard experiment; and the steps required to modify the existing equipment are outlined. A review was made of data on ionospheric drifts and their analysis that have already appeared in the literature; and some of these data pertaining to the lower and upper ionospheres are summarized. M.W.R.

**N67-14650*#** Illinois Univ., Urbana. Aeronomy Lab.
**DIRECT MEASUREMENTS CONFERENCE**
Belva Edwards et al *In its* Res. in Aeronomy 31 Mar. 1966 p 134–137 refs (See N67-14641 05-13) CFSTI: HC $4.00/MF $1.00

Administration and reporting results of the second conference on "Direct Aeronomic Measurements in the Lower Ionosphere" are outlined. Preparations made for the conference attended by 105 persons, including 11 from foreign countries, are reviewed. M.W.R.

**N67-14651*#** Illinois Univ., Urbana. Aeronomy Lab.
**PARTIAL REFLECTION EXPERIMENT**
C. F. Sechrist, Jr. et al *In its* Res. in Aeronomy 31 Mar. 1966 p 138–143 (See N67-14641 05-13) CFSTI: HC $4.00/MF $1.00

System gain required to obtain satisfactory performance of the partial reflection sounder is estimated; and design, construction, and maintenance of the instrumentation for use in the sounder measurements are described. Previous experiments and noise measurements conducted following the installation of the partial reflection experiment indicated that at least 20 db additional gain was necessary for successful operation of the equipment. This was accomplished by increasing the pulse repetition rate of the existing transmitter from a maximum of 5 pps to 60 pps to achieve signal integration on the recordings; and, thereby, to give an apparent improvement in signal to noise ratio for repetitive signals recorded on the film. Modifications in the existing transmitter to meet these increased rates required the design and construction of a 5,000 volt, 100 ma power supply; a new pulse generator; and metering circuits to accommodate increased power. M.W.R.

**N67-14654#** Joint Publications Research Service, Washington, D. C.
**NOCTILUCENT CLOUNDS AND BALL LIGHTNING**
9 Dec. 1966 38 p refs Transl. into ENGLISH from Priroda (Moscow), no. 9, Sep. 1966 p 48–53; 84–92
(JPRS-39032; TT-66-35455) CFSTI: $2.00

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1. NOCTILUCENT CLOUDS I. A. Khvostikov p 1–13 refs (See N67-14655 05-13)

2. BALL LIGHTNING G. S. Teletov p 14–33 refs (See N67-14656 05-13)

**N67-14655#** Joint Publications Research Service, Washington, D. C.
**NOCTILUCENT CLOUDS**
I. A. Khvostikov *In its* Noctilucent Clouds and Ball Lightning 9 Dec. 1966 p 1–13 refs (See N67-14654 05-13) CFSTI: $2.00

Theories on the origin and composition of noctilucent clouds are discussed. The possibility of the aqueous origin of these clouds is compared to the theory that noctilucent clouds are accumulations of dust matter. It is reported that rocket sounding experiments have revealed the presence of ice in the composition of cloud particles which substantiates the aqueous origin theory. However, it is noted that this discovery does not mean the question of origin has become finally cleared up because errors in high altitude moisture content calculations have been discovered. A.G.O.

**N67-14656#** Joint Publications Research Service, Washington, D. C.
**BALL LIGHTNING**
G. S. Teletov *In its* Noctilucent Clouds and Ball Lightning 9 Dec. 1966 p 14–33 refs (See N67-14654 05-13) CFSTI: $2.00

The nature of ball lightning is discussed, and various hypotheses are considered which attempt to account for the origin of this phenomenon. The outward appearance of the powerful lightning discharge, its pattern of movement in space, and other observed physical properties are covered. A.G.O.

**N67-14658#** Joint Publications Research Service, Washington, D. C.
**PHYSICAL GEOGRAPHY**
5 Dec. 1966 271 p refs Transl. into ENGLISH from the book "Chung-Kuo T'i-Li-Hsueh-Hui 1963 Nien-Hui Lun-Wen Hsuan-Chi--Tzu-Jen Ti-Li-Hsueh" Peking, Sci. Publishing House, Dec. 1966 108 p Selected papers of 1963 Ann. Conf. of the Geography Soc. of China
(JPRS-38956; TT-66-35379) CFSTI: $6.00

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1. PRELIMINARY STUDY ON LAND TYPES AND NATURAL REGIONS OF MOUNTAIN AREAS OF PEIPING L. Chao and C.-w. Li p 1–47 refs (See N67-14659 05-13)

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3. NATURAL REGIONS OF THE ORDOS AND THEIR AGRICULTURAL ASSESSMENTS Chuan-k'ang Chen p 72–107 refs

4. SYNTHETIC EVALUATION OF AGRICULTURAL NATURAL RESOURCES AND PHYSICAL CONDITIONS OF THE ULAN PUHO DESERT Sung-ch'iao Chao p 108–133

5. DISCUSSION ON WAYS AND MEANS TO TRANSFORM AND UTILIZE CH'A-HAN-WU-SU--T'IEH-WA SAND REGION IN EAST TSAIDAM BASIN OF TSINGHAI PROVINCE Jen-chang Yang and Shih-jung Su p 134–154

6. LAND TYPES AND THEIR QUALITY EVALUATION IN KIRIN PROVINCE Kuei-ho Ching p 155–175 refs

7. CLASSIFICATION AND BASIC CHARACTERISTICS OF VERTICAL NATURAL ZONES IN MOUNTAIN AREAS OF HONON PROVINCE K.-y. Chang and C.-c. Chang p 176–218 refs (See N67-14660 05-13)

8. PROBLEMS IN DIVIDING THE TROPICS OF SOUTH CHINA INTO ZONES ACCORDING TO THE DISTRIBUTION OF SOME TROPICAL CROPS Chao-hsuan Tsang and Kuo-chen Li p 219–246 refs

9. DISCUSSION ON ZONAL CHARACTER OF AGRICULTURE IN KANSU PROVINCE IN TERMS OF ORDERLINESS IN ITS PHYSICAL GEOGRAPHY Te-hsin Huang p 247–285

**N67-14659#** Joint Publications Research Service, Washington, D. C.
**PRELIMINARY STUDY ON LAND TYPES AND NATURAL REGIONS OF MOUNTAIN AREAS OF PEIPING**
Lin Chao and Ch'ang-wen Li *In its* Phys. Geography 5 Dec. 1966 p 1–47 refs (See N67-14658 05-13) CFSTI: $6.00

The physical characteristics of the mountain regions of Peiping are related to the natural landscape variations for the purpose of land type classification. On the basis of the land type studies, the mountain lands are divided into natural regions by means of

drawing regional boundary lines on land types maps. Emphasis is placed on the principles which were observed in classifying the higher level units of land types and combining them into landscapes. A.G.O.

**N67-14660#** Joint Publications Research Service, Washington, D. C.
**CLASSIFICATION AND BASIC CHARACTERISTICS OF VERTICAL NATURAL ZONES IN MOUNTAIN AREAS OF HONAN PROVINCE**
Kuang-yeh Chang and Chin-ch'uan Chang *In its* Phys. Geography 5 Dec. 1966 p 176–218 refs (See N67-14658 05-13) CFSTI: $6.00

The vertical natural zones in the mountains of Honan province are studied to point out the physical geographical characteristics of the various mountain areas and to relate the general rules governing these characteristics. It is emphasized that this knowledge is of great significance in the development and utilization of the mountain areas as well as in the natural regionalization of these areas. A.G.O.

**N67-14726#** Air Force Cambridge Research Labs., Bedford, Mass. Upper Atmosphere Physics Lab.
**BALLOON-BORNE MASS SPECTROMETER MEASUREMENTS OF THE CONSTITUENTS OF THE ATMOSPHERE TO 28 KILOMETERS**
Rocco S. Narcisi, Robert A. Langley, Herbert A. Cohen, and John M. Elwell May 1966 34 p refs *Its* Environmental Research Papers No. 197
(AFCRL-66-339; AD-639823) CFSTI: HC $2.00/MF $0.50

To determine the feasibility of making mass spectrometric measurements of the lower atmosphere, balloon flights have been made to an altitude of 28 km with a time-of-flight mass spectrometer. Composition measurements were obtained, and some of the problems of extending the range and accuracy of measurements resolved. Author (TAB)

**N67-14735#** Utah Univ., Salt Lake City. Upper Air Research Lab.
**A SOFT ELECTRON SPECTROMETER FOR AURORAL RESEARCH**
David F. Stout Aug. 1966 94 p refs
(Contract AF 19(628)-4995)
(UU-66-9; SR-5; AFCRL-66-604; AD-639694) CFSTI: HC $3.00/MF $0.75

A few of the problems associated with the measurement of electron directional flux inside an aurora by a rocket probe are analyzed. The trajectories of electrons with energies between 40 eV and 10 keV are studied and their interference with the rocket is examined. It is found that a serious measurement problem exists if the electron detection device is mounted incorrectly on the rocket. Secondary electrons below 1 keV energy are also found to be a problem. A partial solution to these problems is presented; and since the problems cannot be completely eliminated, a few methods are proposed to correct the erroneous data which they cause. A design procedure for an instrument capable of obtaining an electron spectrum by electrostatic selection is shown. Deflection plates with cylindrical geometry are found to offer certain advantages for the present system. The resulting deflection system geometry is able to resolve 6 bands of electron energies with band centers at 59.3, 149, 362, 910, 2275, and 5680 eV. A new device, the curved channel electron multiplier, is used to detect individual electrons. A brief outline of its theory of operation is presented and the advantages of this multiplier for sounding rocket experiments are also discussed. Author (TAB)

**N67-14736#** White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
**THE RATIO OF THE EXCHANGE COEFFICIENTS FOR HEAT AND MOMENTUM IN A HOMOGENEOUS THERMALLY STRATIFIED ATMOSPHERE**
Frank V. Hansen Jun. 1966 30 p refs
(ECOM-5059; AD-639961) CFSTI: HC $2.00/MF $0.50

A hypothesis concerning the ratio of the exchange coefficients for heat and momentum is formulated. From the basic assumptions of the Monin-Obukhov similarity theory and the theory of free convection, it is shown that the ratio of the coefficients is a two-part function of the nondimensional logarithmic wind shear and the gradient Richardson number. Experimental data tend to corroborate the theoretical values derived in this study within the limits of experimental error. Author (TAB)

**N67-14739#** Polytechnic Inst. of Brooklyn, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
**FLOW OF RADIATING GAS PAST A CORNER**
Prem K. Khosla Jun. 1966 18 p refs
(Contract Nonr-839(34))
(PIBAL-981; AD-640251) CFSTI: HC $1.00/MF $0.50

An iterative method to solve the nonlinear problem for the flow of a radiating gas past a corner is given and its relation to the results already obtained from linearized solution is indicated. The method centers around what is called the local temperature approximation. Author (TAB)

**N67-14740#** Air Force Cambridge Research Labs., Bedford, Mass. Terrestrial Sciences Lab.
**BIBLIOGRAPHY OF EXPERIMENTAL ROCK DEFORMATION, SECOND EDITION, PART II**
R. E. Riecker Aug. 1966 15 p refs *Its* Spec. Rept. No. 35 (II)
(AFCRL-65-740(II); AD-640320) CFSTI: HC $1.00/MF $0.50

This first supplement to the Bibliography of Experimental Rock Deformation, Second Edition, (AD-627 002) AFCRL-65-740, October 1965, lists 111 cross-referenced research articles taken from scientific journals and books. The listings include the following 29 categories: Apparatus, Brittle Behavior, Calcite, Calibration, Conductivity, Creep, Dislocations, Fabric, Friction, General, Ice, Marble, Olivine, Phase Studies, Quartz, Recrystallization, Resistance, Sedimentary Rocks, Seismic Velocities, Shear, Shock, Strain Rate, Surveys, Viscosity, and X-ray. Author (TAB)

**N67-14760#** Alberta Univ., Edmonton. Dept. of Physics.
**CRUSTAL STRUCTURE IN WESTERN CANADA Final Report, May 1, 1963–Apr. 30, 1966**
G. L. Cumming and E. R. Kanasewich 30 Jun. 1966 194 p refs
(Contract AF 19(628)-2835; ARPA Order 292; Proj. Vela Uniform)
(AFCRL-66-519; AD-639679) CFSTI: HC $5.00/MF $1.00

The report deals with crustal seismic refraction and reflection measurements in Western Canada. Evidence is presented to support three major layers in the crust below the sediments, with velocities of 6.1, 6.5 and 7.2 kilometers per second, overlying the upper mantle with velocity close to 8.2 kilometers per second. The total crustal thickness is about 45 kilometers. Refraction measurements indicate substantial lateral velocity variations in the crust, and these are related to large variations in the gravity field. Preliminary data suggest the presence of a low velocity layer in the upper mantle at a depth of about 120 kilometers. Reflection measurements indicate that a strong reflecting horizon is present at a depth close to the top of the 7.2 kilometer per second layer, and this reflector appears to be continuous over distances of several tens of kilometers. Author (TAB)

**N67-14868#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**THE NIGHT GLOW OF THE ATMOSPHERE IN THE λ6300 A REGION**

T. M. Tarasova *In its* Cosmic Res. 4 Aug. 1966 p 100–112 refs (See N67-14861 05-30) CFSTI: HC$6.00/MF$1.50

Data obtained in September 1960 by means of a rocket photometer which operated in the altitude region of 64–200 km is presented. A discussion is presented of the materials pertaining to those segments of the trajectory in which the instrument executed a slow rotation, scanning the portion of the sky from the zenith to the horizon. For the spectral region of $\lambda_{max}$ = 6300 A ($\Delta\lambda$ = 240 A) we show the significant difference between the theoretical and experimental magnitudes of the ratio of luminosity intensity at the horizon to the luminosity intensity at the zenith. Thus it is demonstrated that the concept of the localization of atomic-oxygen red-line luminosity at an altitude of 300 km does not explain the derived experimental data, if we proceed from the presently accepted concept of radiation in the continuous spectrum of the night sky. Author

**N67-14869#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**RESULTS FROM AN INVESTIGATION INTO THE DISTRIBUTION OF THE ELECTRON CONCENTRATION IN THE IONOSPHERE BY THE METHOD OF GROUND RECEPTION OF RADIO SIGNALS FROM THE "ELEKTRON-1" ARTIFICIAL EARTH SATELLITE**

N. A. Mityakov, E. Ye. Mityakova, and V. A. Cherepovitskiy *In its* Cosmic Res. 4 Aug. 1966 p 113–127 refs (See N67-14861 05-30) CFSTI: HC$6.00/MF$1.50

The effect of thickness of the ionosphere above the maximum of the F layer is determined on the basis of the results from measurements of the integral electron concentration $\int_0^{\infty} Ndz$ to the height of the satellite and on the basis of data from the vertical sounding stations. The diurnal variations of certain parameters characterizing the distribution of electron concentration with respect to altitude is discussed. Author

**N67-14900*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**ANNUAL MEAN VALUES OF GEOMAGNETIC ELEMENTS SINCE 1900**

Joseph C. Cain Mar. 1965 131 p refs

(NASA-TM-X-59263) CFSTI: HC$3.00/MF$1.30 CSCL 08N

A series of observatory annual mean values are tabulated as a by-product of an analysis for the main geomagnetic field and its secular variation. The locations of the magnetic observatories for which annual mean values are available are presented. The annual mean listing is organized by country or area, observatory name, and coordinates in geodetic latitude and longitude. Positions are given in degrees and minutes to tenths of minutes. S.P.

**N67-14913*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

**ON CROSS-BEAM MONITORING OF ATMOSPHERIC WINDS AND TURBULENCE WITH TWO ORBITING TELESCOPES**

F. R. Krause, S. S. Hu, and A. J. Montgomery 14 Nov. 1966 93 p refs Prepared in part at Northrop Space Labs. and IIT Res. Inst.

(Contracts NAS8-20082; NAS8-20107)

(NASA-TM-X-53538) CFSTI: HC$3.00/MF$1.30 CSCL 04A

This report documents the feasibility study of a crossed-beam test arrangement which employs triangulation of two collimated beams of radiation for the remote sensing of the space and time variations of thermodynamic state variables such as tracer concentrations. The generation, convection and decay of trace constituents (aerosols, ozone, and water vapor) will modulate the mean radiative power, which is put into the telescope's field of view by an extended radiation background such as scattered sunlight or thermal emission. The associated fluctuations of radiative power are then correlated to retrieve local information at the beam intersection from the integrated optical signals. The potential of crossed-beam test arrangement is illustrated by discussing analytically the measurement of horizontal wind profiles. It is conceivable to conduct crossed-beam missions with two astronomical telescopes which are mounted on a single spacecraft in such a way that they point towards the earth. Author

**N67-14942#** Air Force Cambridge Research Labs., Bedford, Mass. Meteorology Lab.

**AN ANALYSIS OF SONIC ANEMOMETER MEASUREMENTS FROM THE CEDAR HILL TOWER**

J. Chandran Kaimal Aug. 1966 163 p refs *Its* Environ. Res. Paper No. 215

(AFCRL-66-542; AD-641226) CFSTI: HC$5.00/MF$1.00

In a field program conducted during the summer of 1963, sonic anemometers were operated at four levels on a 1400-ft tower to obtain measurements of the vertical velocity fluctuations under different stability conditions. This report provides a detailed description of the instrumentation, data reduction and analysis technique, and a complete listing of the processed spectral data. The results for four runs representing different but typical conditions are analyzed and interpreted. The main conclusion drawn from this study is that simplified concepts used for describing the vertical structure of turbulence near the ground do not apply to heights above 150 ft. Author (TAB)

**N67-14954#** Technische Hochschule Munchen (West Germany). Electrophysikalisches Institut.

**INVESTIGATIONS OF ULF-RADIATION Final Scientific Report, 1 Jul. 1963–28 Feb. 1966**

Ludwig Rohrer 10 Mar. 1966 24 p refs

(Contract AF 61(052)-725)

(AFCRL-66-675; AD-642634) CFSTI: HC$3.00/MF$0.65

Electric and magnetic fields of naturally occurring electromagnetic radiation in the frequency range 0.025–0.25 cps were received and analyzed. A long-wire array and an induction coil were used as pickup devices for the electric and the magnetic field, respectively. After separate amplification, both signals were recorded simultaneously on magnetic tape. To obtain a frequency transformation, the recorded signals were played back at a much higher tape speed than used for recording. Spectral analysis of the recorded signals was performed. It was found that pulsations of the electric and the magnetic field often occur simultaneously at the same frequency. The mean spectra of the two fields was computed for the signals received during one 24 hour period. Author (TAB)

**N67-14957#** State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.

**THE HOOK WHISTLER—A NEW EQUATORIAL WHISTLER OBSERVED BY INJUN 3**

Donald A. Gurnett, S. D. Shawhan, and G. W. Pfeiffer Oct. 1966 9 p refs

(Contract Nonr-1509(08))

(Rept.-66-50; AD-642631) CFSTI: HC$3.00/MF$0.65

A new type of whistler, called the hook whistler, is reported. This new type of whistler has been found in the very-low-frequency radio noise data from the Injun 3 satellite. The hook whistler consists of two whistler-like components separated by a frequency dependent time delay varying from zero to about 200 milliseconds. The two components are believed to arise from different propagation paths from the lightning source to the satellite. Author (TAB)

N67-14976# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
**ULTRASONIC PULSE MEASUREMENTS IN ANISOTROPIC LAKE ICE**
Hans Roethlisberger Jul. 1966 29 p refs
(CRREL-RR-126; AD-642110) CFSTI: HC $3.00/MF $0.65

Travel-time measurements of ultrasonic pulses were carried out in March 1960 on Lake Superior (Keweenaw Bay) near Barage, Mich. The ice was about 45cm thick and consisted of grains with vertical C-axis orientation with the exception of a surface layer of variable thickness. Ultrasonic pulses were transmitted and received by Barium Titanate cells of cylindrical and spherical shape. The transducers were mounted at the surface and the distance was varied. Several direct and reflected signals could be identified. Of the reflected events, the PS type were the clearest and strongest at distances many times the ice thickness, and thus best suited for ice thickness determination. In order to obtain satisfactory agreement between theoretical and measured travel times the anisotropy of the ice had to be taken into account. The elastic constants determined by Bass et al. (1957) gave reasonably good agreement between computed and measured travel time, but some discrepancies remain to be explained. Part of the observed reflections occurred on cracks in the ice. Using equipment with approximately 100-kc signals the ice thickness was determined by the ultrasonic pulse method, destruction free, with an accuracy of 2–4 cm or 5–10%. For day-to-day comparisons the relative accuracy would be in the order of 0.5 cm. Author (TAB)

N67-14981# IIT Research Inst., Chicago, Ill.
**ANALYSIS OF LOW LATITUDE AND E REGION DATA**
**Semiannual Technical Report, 15 Nov. 1965–15 May 1966**
Robert D. Sears Sep. 1966 56 p refs
(Contract N00014-66-C0030; ARPA Order 749)
(T-6142; AD-640991) CFSTI: HC $3.00/MF $0.50

Analyses of ionograms, high frequency phase and amplitude data and riometer measurements of absorption which will lead to a better determination of the D and E region electron density profile for low latitude regions are described. True height analyses of sample ionograms allows determination of the contribution of the F region to 30 MHz absorption as determined from the riometer data. The topside F region is fit by a Chapman layer and F region temperature effects are qualitatively considered to show that the computer absorption from the F region tends to be a maximum estimate for that region. The computation of diurnal absorption variation from the 30 MHz riometer data requires that the cosmic noise power which would be received in the absence of absorption be computed. A program which has been developed to predict the cosmic noise diurnal variation given a particular site and antenna pattern has been improved and the results to date are described. The separation of E and F region reflection modes by comparison of the phase data with ionogram virtual group paths for the same frequencies shows that the different modes can be separated in the data with little ambiguity. Theory which forms the basis of the analysis of phase, amplitude, group path, and absorption data is summarized and two sample analyses are performed to show the sensitivity of the Faraday fading data to small changes in electron content along the signal path. The group and phase data are compared with the amplitude results to show their relationship and the means of identifying the height of variation of electron content along a propagation path. Author (TAB)

N67-15006# Alaska Univ., College. Geophysical Inst.
**STUDY OF THE ALBEDO OF THE EARTH Final Report**
Wallace B. Murcray Sep. 1966 17 p refs
(Contract Nonr-3010(03))
(AD-642356) CFSTI: HC $3.00/MF $0.65

A number of observations of the earthlight reflected from the moon were made during 1963–65. The observations did not cover a sufficient range of earth phase to obtain a phase curve for the earth and the one given by Danjon for a different portion of the earth does not seem quite adequate. Using Danjon's curve, the values obtained for the albedo of the portion of the earth which includes Asia during the months of February and March are very high. Author (TAB)

N67-15010# RAND Corp., Santa Monica, Calif.
**SCATTERING FUNCTIONS FOR RAYLEIGH ATMOSPHERES OF ARBITRARY THICKNESS**
Z. Sekera and Ann B. Kahle Oct. 1966 80 p refs
(Contract AF 49(638)-1700; Proj. Rand)
(R-452-PR; AD-642366) Available from RAND Corp., Santa Monica, Calif. CFSTI: $3.00

Radiation emerging from the top and bottom of a plane-parallel planetary atmosphere is characterized by the intensity and polarization parameters. These parameters can be easily calculated once Chandrasekhar's X- and Y-functions and the related Kand L-functions have been correctly evaluated. Numerical values of these functions are presented for the case of Rayleigh scattering. The functions are tabulated for a wide range of values of optical thickness, $\tau$, of the atmosphere ($0.15 \leq \tau \leq 100$) and a complete range of directional parameters. The ordinary moments, from order zero through four, of all the functions are also tabulated. Suggestions for additional uses of the tables are made. Author (TAB)

N67-15027# Naval Research Lab., Washington, D. C.
**ON THE DETERMINATION OF FINE SCALE IONOSPHERIC INHOMOGENEITIES BY MEANS OF A FARADAY ROTATION ANALYSIS OF ECHO II RADAR RETURNS**
John M. Goodman 19 Sep. 1966 24 p refs
(NRL-MR-1723; AD-640330) CFSTI: HC $1.00/MF $0.50

Radar returns from Echo II satellite were obtained during a period of sunspot minimum at Randle Cliff (NRL-CBD). By means of a Faraday rotation analysis it was tentatively concluded that electron content inhomogeneities of a few percent exist over horizontal scales of between 8 and 24 kilometers. It was concluded that the accuracy of the technique which was employed to deduce the inhomogeneities could be improved by increasing the radar signal to noise ratio and by operating at a lower radar frequency –possibly in the HF range. Author (TAB)

N67-15048# Ballistic Research Labs., Aberdeen Proving Ground, Md.
**FIVE-INCH HARP TESTS AT BARBADOS, WEST INDIES, JANUARY–FEBRUARY 1966**
Eugene D. Boyer Jul. 1966 26 p refs
(BRL-M-1771; AD-640438) CFSTI: HC $2.00/MF $0.50

The installation of a 5-inch HARP gun system at Barbados, West Indies, is presented. The system is employed to carry a low cost wind sensor to 200,000 feet altitude. Author (TAB)

N67-15059# Oslo Univ., Blindern (Norway). Norwegian Inst. of Cosmic Physics.
**APPEARANCE OF ENHANCED VLF-EMISSION ON 8 KC/S OBSERVED ALONG A N–S CHAIN OF STATIONS**
L. Harang 15 Jun. 1966 25 p refs
(Contract AF 61(052)-811)
(AFCRL-66-684; SR-5; AD-640470) CFSTI: HC $1.00/MF $0.50

VLF-emissions on 8 kc/s have been recorded simultaneously along a chain of stations in N-S direction: Tromso, Lycksele, Oslo and Chambon la Foret, covering a latitude difference from 70 degrees to 48 degrees N. It is shown that the polar VLF-emissions recorded close to the auroral zone at Tromso during the night also can be traced on the records from Oslo with amplitudes of about 1/k00 - 1/500 of the Tromso amplitudes. A new type of VLF-emissions has been shown to appear at the stations Lycksele – Oslo, but not appearing at Tromso and Chambon la Foret. These low-latitude VLF-emissions appear during day time. There is thus a time difference of about 12 hours in the mean appearance of

these two types of VLF-emissions. It is further pointed out that whereas the polar VLF-bursts appear during weak or moderate geomagnetic storms and in many cases a coincidence in details appears between the amplitudes of the VLF-bursts and the geomagnetic variations, the low-latitude emission appear in the day and start after the commencement of a great geomagnetic storm, usually 10-16 hours after the start. There are thus reasons to believe that the two types of VLF-emissions, the polar type recorded close to the auroral zone, and the low-latitude type recorded 5 degrees – 10 degrees to the south of the auroral zone are produced by different primary processes of excitation. Author (TAB)

N67-15065# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ACCOUNTING FOR SELENO-SOLAR TIDAL INFLUENCES IN GRAVIMETRIC MEASUREMENT**

Ye. A. Mudretsova 18 Apr. 1966 15 p refs Transl. into ENGLISH from Izvest. Vyshikh Uchebn. Zavedenii, Geol. i Razvedka (Moscow), no. 10, 1962 p 113–199
(FTD-TT-65-739; TT-66-62510; AD-640956) CFSTI: HC $1.00/MF $0.50

When reducing gravimetric measurements in underground mining developments at pyrite deposits in the middle Urals it is necessary to take into account seleno-solar tidal influences on measurement results. TAB

N67-15072# IIT Research Inst., Chicago, Ill.

**ADVANCED STUDY INSTITUTE, AURORA AND AIRGLOW, AUGUST 15–26, 1966, KEELE, ENGLAND Final Report**

Billy M. McCormac and W. O. Davies Oct. 1966 26 p
(Contracts OI-18-001-66-12798(X); N00014-66-CO-331)
(IITRI-T-6144; AD-641422) CFSTI: HC $2.00/MF $0.50

After over forty lectures and a vast amount of discussion on the various aspects of aurora and airglow, some effort should be made to present a conclusion. The Institute did not attempt to reach agreements or to determine popular opinion, but rather to see that the experimental and theoretical results were presented and adequately discussed. Each individual must make his own evaluation as to the importance and credibility of the information. Personal conclusions of the Institute are presented from the point of view of future research requirements. This Institute did much to identify important areas of agreement and disagreement and to focus attention on multidisciplinary research and on key problems for the future. The attendees concluded that another two-week Institute on Aurora and Airglow should be held in 1968. Author (TAB)

N67-15101# Avco Corp., Wilmington, Mass. Research and Technology Labs.

**INFRASONIC MODES: AN OMNIBUS DIGITAL COMPUTER PROGRAM FOR THE STUDY OF ACOUSTIC-GRAVITY WAVE PROPAGATION**

Allan D. Pierce 5 Sep. 1966 98 p refs
(Contract AF 19(628)-3891)
(AVSSD-0230-66-CR; SR-7; AFCRL-66-669; AD-641367) CFSTI: HC $3.00/MF $0.75

A computer program written in FORTRAN II for the purpose of studying guided infrasonic (acoustic-gravity) waves in the atmosphere is described. The deck listing of the main program and 43 subroutines is included. The program is based on the multilayer approximation which considers the atmosphere as consisting of a large number (up to 100) of layers, each having constant temperature and wind velocity. Such a model atmosphere may be chosen to approximate any continuously stratified model atmosphere. The report includes instructions for the operation of the program and examples of output. Author (TAB)

N67-15104# Massachusetts Inst. of Tech., Cambridge. Dept. of Geology and Geophysics.

**RARE EARTH FRACTIONATION IN HAWAIIAN VOLCANIC ROCKS**

Jean-Guy Schilling (Ph.D. Thesis) Aug. 1966 395 p refs
(Contract Nonr-1841(74))
(AD-642344) CFSTI: HC $3.00/MF $0.65

The procedure for determination of the rare earth elements and yttrium utilizing tracer-monitored group separation, neutron activation and carrier-free partition chromatography developed by Volfovsky et al. (1963) was revised and improved. Using this improved procedure, rare earth and yttrium abundances were measured in twenty Hawaiian lavas of known chemical and mineralogical composition, one peridotite inclusion from Salt Lake Crater, Oahu, and one olivine-rich nodule and its host 1801 basalt flow from Hualalai, Hawaii, and a diabase from Oahu. When comparing the rare earths, element by element, in the twenty lavas, to a low potassium olivine tholeiite, four distinct groupings were observed. The origin and genetic relationships of these different groups are discussed in the light of their rare earth patterns, mineral patterns from other localities, experimental petrology, theoretical and geochemical reasoning. Possible processes operative in the formation of these lavas, such as fractional crystallization, partial melting, fractional melting, limestone syntexis and fractional resorption are explored. The origin of the ultramafic inclusions is also briefly discussed. Author (TAB)

N67-15150*# Illinois Univ., Urbana. Electrical Engineering Research Lab.

**RESPONSE OF IONOSPHERIC ELECTRON DENSITY TO A CHANGE OF ELECTRON TEMPERATURE**

T. R. Pound and K. C. Yeh Dec. 1966 139 p refs
(Grants NsG-24; NSF GP-411)
(NASA-CR-81079) CFSTI: HC $3.00/MF $1.95 CSCL 04A

Using a spatial model of the ionosphere in which the F2 region ionization loss rate is assumed to be much slower than the rate of production of ionization and the rate of transport of ionization to the lossy lower region of the ionosphere, several aspects of F2 region behavior for near sunspot minimum conditions have been investigated. With a temporal model in which the transition between temporal phases is assumed to be a step function, the behavior of the electron number density and content in the daytime and nighttime ionosphere and the transition between these temporal phases, sunset and sunrise, has been shown to possess an extremely high degree of consistency and to show close relationships. Author

N67-15156*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**IONOSPHERIC POLAR BLACKOUT INDICES DURING 1957–1965**

Yukio Hakura, Yugoro Takenoshita, and Koichi Matsuoka (Radio Res. Labs.) Aug. 1966 39 p refs
(NASA-TM-X-55635; X-640-66-383) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Daily indices of ionospheric blackout incidence both in the polar cap and in the auroral zone are constructed for years 1957–65. The indices increase approximately as the logarithm of the total number of hours of blackouts for each U.T. day, the scale being 0 to 8. The auroral zone blackout index $I_A$ increases generally in parallel with polar geomagnetic activity, while the index $I_P$ indicates the degree of the PCA activity which is caused by solar cosmic ray's invasion into the polar cap. Annual mean of $I_P$ index changes in parallel with that of Zürich sunspot numbers. Little recurrency is found in the $I_P$. On the other hand, the $I_A$ index shows a clear recurrency of 27 days throughout the half solar cycle examined, suggesting that production of energetic electrons responsible for the AZA is strongly controlled by solar wind activity. Author

N67-15174# Joint Publications Research Service, Washington, D. C.
**REGULARIZATION OF THE EARTH**
M. A. Alekzidze 9 Jan. 1967 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 170, no. 5, 1966 p 1064–1067
(JPRS-39456; TT-67-30106)

The principal requirements imposed on the methods for regularization of the earth are as follows: (1) There must be no attempt attracting masses beyond the surface of the geoid; (2) The earth's mass must be constant; (3) The surface of the geoid must not change; and (4) The geoid and the spheroid must have common centers of mass. It is shown that in theory it is impossible to develop a regularization method satisfying the first three requirements and therefore, an effort is made to satisfy them approximately. A.G.O.

N67-15281# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
**SEISMIC SURVEY NORTHWEST GREENLAND, 1964**
Garry K. C. Clarke Jul. 1966 26 p refs
(CRREL-RR-191; AD-640454) CFSTI: HC $2.00/MF $0.50

The thickness of the Greenland Ice Cap was determined by seismic sounding along the trail from Camp Tuto to Camp Century in Greenland and on traverses northwest and southwest from Camp Century. The average velocity of vertically traveling seismic waves at each shot location was estimated using the first-arrival data from reflection records and the 10-m temperature at each location. The results of three long refraction profiles and measurements of temperature, density, and seismic velocities at the Camp Century drill hole were used to check velocity estimates. An empirical formula from Robin satisfactorily related seismic wave velocities to the temperature and density of the firn and ice. A two-layer glacier model having a homogeneous ice layer overlain by a firn layer in which the P-wave velocity increased linearly with depth was used. Author (TAB)

N67-15287# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
**PRESSURE WAVE PROPAGATION IN SNOW WITH NONUNIFORM PERMEABILITY**
Yin-Chao Yen and S. S. T. Fan (N. H. Univ.) Aug. 1966 16 p refs
(CRREL-RR-210; AD-640451) CFSTI: HC $1.00/MF $0.50

A mathematical analysis of pressure wave propagation through a deep layer of snow with nonuniform permeability is presented. The study extends previous investigations on porous media in which the physical properties and imposed boundary conditions have been assumed or kept constant. Two cases of boundary conditions were considered. Case I: imposed pressure at the boundary remains constant. Case II: imposed pressure at the boundary falls exponentially with time. Darcy's law was assumed to be valid. The nonlinear differential equation was solved by the finite difference technique and the results are presented in terms of dimensionless variables. Author (TAB)

N67-15306# Brown Univ., Providence, R. I. Dept. of Geological Sciences.
**STUDIES OF EXTRATERRESTRIAL PARTICLES IN SEDIMENTARY ROCKS Final Report, May 1963–Sep. 1966**
Thomas A. Mutch Sep. 1966 83 p refs
(Contract AF 19(628)-2841)
(AFCRL-66-628; AD-640498) CFSTI: HC $3.00/MF $0.75

A number of sedimentary rocks, chiefly rock salts, have been processed for the recovery of possible extraterrestrial particles. The only recognizable particles in this category are opaque magnetic spherules composed chiefly of magnetite. The mode of occurrence of the spherules suggests an extraterrestrial origin, though neither the chemistry or mineralogy of individual particles is uniquely meteoritic. Influx rates calculated for spherules contained in Silurian and Permian salts are closely similar to those calculated by Crozier (Nine years of Continuous Collection of Black Magnetic Spherules from the Atmosphere: J. Geo phys. Res. 71, 603-611) for the recent geologic age. This suggests a general constancy of meteoritic activity throughout this period of geologic time. Author (TAB)

N67-15307# Pennsylvania State Univ., University Park. Dept. of Geology and Geophysics.
**SPECTRAL ANALYSIS OF SHORT-PERIOD FIRST ARRIVALS OF THE APRIL 13, 1963 PERUVIAN EARTHQUAKES Special Technical Report No. 4**
Gabriel Leblanc 15 Jun. 1966 156 p refs
(Contract AF 19(628)-238; ARPA Order 180-61; Proj. Vela-Uniform)
(AFCRL-66-569; AD-639743) CFSTI: HC $5.00/MF $1.00

The short-period vertical seismograms of 37 stations for the Peruvian earthquake of April 13, 1963 were Fourier-analyzed for a time duration of 10 plus or minus 0.5 sec. After proper instrumental corrections, the 37 frequency spectra were found to be quite similar in their overall shape, but very different in their finer structure. The similarity of the envelope appears to be most probably associated with the source while the crustal effect could account for the differences in the finer spectral structure. By using theoretical calculations based on the Thompson-Haskell matrix formulation, the crustal effect of any layered system on an incoming dilatational wave can be obtained. It was found that the distance affects mostly the level of the spectrum, and not its slope and character. The azimuthal effect manifests itself by a change in the slope of the spectral envelope and a shift of the cut-off frequency. The crustal effect appears to be so considerable that the other effects are impossible to measure accurately until the crustal effect has been removed by inverse-filtering. Author (TAB)

N67-15313# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
**TEMPERATURE DEPENDENCE AND MECHANISM OF SINTERING**
Rene O. Ramseier and Gary W. Sander Jul. 1966 23 p refs
(CRREL-RR-189; AD-640150) CFSTI: HC $1.00/MF $0.50

The results are presented of a study of the sintering process as a function of temperature, keeping size distribution, shape, and density nearly constant. The confined compression test method was used. It is shown that the degree of sintering of snow and the rate constant as a function of temperature can be represented satisfactorily by an exponential equation. The results indicate that the sintering process is one of evaporation, diffusion through the ambient temperature, and condensation. Author (TAB)

N67-15318# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
**SOLUTION OF STOKES' PROBLEM WITH THE PROPORTIONAL ERROR OF THE ORDER OF THE SQUARE OF THE EARTH'S FLATTENING [RESHENIYE ZADACHI STOKSA S OTNOSITEL'NOY PROGRESHNOST'YU PORYADKA KVADRATA SZHATIYA ZEMLI]**
M. S. Molodenskiy Aug. 1966 11 p refs Transl. into ENGLISH from Tr. Tsentr. Nauchn.-Issled. Inst. Geodezii, Aeros'yemki i Kartografii (Moscow), issue 112, 1956 p 1–8
(ACIC-TC-1104; TT-66-62280; AD-639113) CFSTI: HC $1.00/MF $0.50

Translation of Russian research: solution of Stoke's problem with the proportional error of the order of the square of the earth's flattening. TAB

N67-15319# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
**SOLUTION OF STOKES' PROBLEM WITH THE PROPORTIONAL ERROR OF THE ORDER OF THE SQUARE OF THE EARTH'S FLATTENING [RESHENIYE ZADACHI STOKSA S OTNOSITEL'NOY POGRESHNOST'YU PORYADKA KVADKATA SZHATIYA ZEMLI]**
B. P. Pertsev Aug. 1966 9 p refs Transl. into ENGLISH from Tr. Tsentr. Nauchn.-Issled Inst. Geodezii, Aeros'yemki i Kartografii (Moscow), issue 112, 1956 p 9–12
(ACIC-TC-1102; TT-66-62279; AD-639112) CFSTI: HC $1.00/MF $0.50

Translation of Russian research: solution of Stoke's problem with the proportional error of the order of the square of the earth's flattening. TAB

N67-15336# Air Force Cambridge Research Labs., Bedford, Mass. Upper Atmosphere Physics Lab.
**U. S. SUPPLEMENTARY ATMOSPHERES**
K. S. W. Champion Aug. 1966 34 p refs Submitted for Publication *Its* AF Surv. in Geophys. No. 184
(AFCRL-66-564; AD-640285) CFSTI: HC $2.00/MF $0.50

A radical new set of model atmospheres was prepared which represent typical atmospheric conditions for summer and winter at various latitudes up to 60 deg and which above 120 km are also functions of time of day and solar flux. These atmospheres connect at 80 km with Cole and Kantor's winter atmospheres for 30, 45, and 60 deg latitude, with their tropical atmosphere for 15 deg latitude and with their summer atmospheres for 30, 45, and 60 deg latitude. The three winter atmospheres merge at a common point at 120 km, with a density 50 percent above U. S. Standard 1962. The three summer atmospheres, plus the tropical atmosphere, merge at 120 km, with a density 20 percent below the U. S. Standard. In addition, a mean atmosphere has been prepared between 80 and 120 km which, in effect, constitutes a revision of the Standard. This atmosphere represents an average over all conditions, but also can be used for spring and fall at latitudes of 30 deg and higher. Each atmosphere has been calculated with a value of the acceleration due to gravity appropriate to the latitude. Starting from the three common points at 120 km are three sets of atmospheres. Each set consists of a number of atmospheres corresponding to exospheric temperatures lying between 600 and 2100K. At the higher altitudes, the seasonal dependence disappears and the variation is diurnal and with solar flux. These atmospheres are calculated using the acceleration due to gravity for a latitude of 45 deg. Author (TAB)

# 14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N67-14490*# Du Pont de Nemours (E. I.) and Co., Wilmington, Del. Engineering Technology Lab.
**HEAT EFFECTS DURING THE DEFORMATION OF SOLID MATERIALS**
H. O. Foster and R. E. Benner (Lehigh Univ.) *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 121–142 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

An instrument is described for measuring heat effects during the deformation of solid materials. The instrument is designed after the stretch calorimeter of Müller and Engelter but embodies several refinements that simplify the operation of the instrument and extend its utility by providing a range of ambient testing temperatures. The time constant of the electronic instruments is about $10^{-3}$ sec, and there is no tendency to overshoot. A first-law energy balance is discussed for natural rubber, crystalline thermopolymers, and metals. In undrawn crystalline polymers, the heat flux at small deformation is similar to that in metals. After drawing, the small deformation heat flux is modified in a manner suggestive of a transition in crystalline order. This effect is discussed and possible interpretations presented. Author

N67-14493*# Grace (W. R.) and Co., Clarksville, Md.
**A SHEAR CREEP VISCOMETER FOR RHEOLOGICAL STUDIES OF POLYMERS**
D. A. Gibbs and E. W. Merril (MIT) *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 183–192 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

The viscometer is essentially three parallel flat metal plates with the polymer held between them. The middle plate is moved with respect to the outer two by means of a constant force, shearing the polymer between the plates. A wide range of temperatures and stress levels can be attained. Shear compliance data are given for a commerical 30% styrene–70% butadiene copolymer. The data were taken over the temperature range −53 to +84.4° C, and reduced to a master curve at 27.8° C. The data are compared with dynamic torsion pendulum data. The melt viscosity of polyisobutylene, $\eta_o = 1.75 \times 10^8$, is given as a function of shear stress. The data illustrate the first Newtonian region, the non-Newtonian region, and the beginning of the second Newtonian region. A plot of log viscosity versus log molecular weight is obtained. The slopes of the curves range from 3.2 for the first Newtonian viscosities to 1.9 for the second Newtonian viscosities. At stresses above $10^6$ dynes/cm.$^2$ melt fracture was observed. Author

N67-14550* Physikalisch-Technische Bundesanstalt, Brunswick (West Germany).
**A ROTATIONAL METHOD FOR MEASURING THE VISCOSITY OF GLASS IN THE RANGE BETWEEN STRAIN POINT AND MELTING TEMPERATURES**
Gustav Meerlender *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 539–554 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

A rotational viscometer is described, which is suitable for measuring the viscosity of inorganic glass in a range from 30 to $10^{4.5}$ poises at temperatures between 500° and 1400°C. The evaluation, calibration, and theory of error are outlined. High viscosities above $10^{10}$ poises were hitherto determined by the methods of fiber elongation or torsion only. There is now a third independent method, with advantages from many viewpoints; in some cases, however, the method of fiber deformation remains more suitable. The different methods are discussed with respect to some experimental peculiarities and time effects. For example, it is possible to separate mechanical and thermal history from each other. For some of these considerations, experimental results are given. Author

N67-14620# Atomic Energy Commission, Washington, D. C. Div. of Isotopes Development.
**ISOTOPE SYSTEMS DEVELOPMENT PROGRAM, SEVENTH ANNUAL CONTRACTORS MEETING**
Mar. 1966 73 p refs Meeting held in Washington, D. C., 6–8 Dec. 1965
(CONF-651208) CFSTI: HC $3.00/MF $0.75

Activities at a meeting to review progress in development of new principles and techniques for using isotopes are reported. Papers presented at the conference are categorized as basic information, analytical aspects, marine device development, environmental applications, industrial applications, aerospace applications, and national security applications. NSA

**N67-14672#** Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Institut fuer Flugmechanik.

**A DIGITAL MEASURING DEVICE TO INDICATE FUEL QUANTITY AND FUEL CONSUMPTION [EIN DIGITALES MESSGERAET ZUR MESSUNG VON KRAFTSTOFFVORRAT UND -VERBRAUCH]**

L. Koch *In* WGRL Session Rept. of the WGRL-Subcomm. on Aerodyn. Measuring Tech. 31 May 1966 p 187–199 (See N67-14661 05-08) CFSTI: HC $6.00/MF $1.25

A digital indicator was developed that uses an inductive flow meter for rapid measurements of fuel quantity and fuel consumption during aircraft flight tests. The main components of this digital counter consist of a shifting register, a binary frequency divider, and a flow regulator. The cylindrical inductive flow meter encorporates a fan wheel that is agitated by the fuel flow; rotational frequency depends linearly on fuel flow velocity and volume and is evaluated by digital electronics. Fuel supply measurements consider the used up amount by time integration. Block diagrams of both, the fuel consumption counter and the fuel quantity indicator, are shown. Transl. by G.G.

**N67-14697#** Aeroprojects, Inc., West Chester, Pa.

**APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS Bimonthly Progress Report, 1 Jun.–31 Jul. 1966**

Aug. 1966 12 p refs

(Contract AT(30-1)-3622)

(NYO-3622-4; BMPR-29) CFSTI: HC $1.00/MF $0.50

Initial tests with an acoustic flowmeter showed promise for the technique, and satisfactory performance should be achieved after minor transmission problems are solved. Study of ultrasonic techniques for measuring pressure in high-temperature systems was initiated. Promising techniques involving measurement of acoustic impedance and resonant frequency are being analyzed. Author (NSA)

**N67-14717#** Naval Ordnance Lab., White Oak, Md.

**DYNAMIC CALIBRATIONS OF PRESSURE DETECTORS AT INFRASONIC FREQUENCIES**

Henry Gerber and M. Peter Eskin 25 May 1966 41 p refs

(NOLTR-66-105; AD-640314) CFSTI: HC $2.00/MF $0.50

The report presents methods for producing pressure signals to check the performance of accurate, sensitive, infrasonic pressure detectors. Step, sinusoidal, uniformly-decreasing, and pulse pressure signals with precisely controlled magnitudes and durations are emphasized. The effects of slight, unavoidable deviations are discussed. Author (TAB)

**N67-14728#** White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

**ROCKET-BORNE OZONESONDE**

Jagir S. Randhawa Jul. 1966 23 p refs

(ECOM-5064; AD-639958) CFSTI: HC $1.00/MF $0.50

A stratospheric ozonesonde was developed which utilizes the chemiluminescent principle for the measurement of ozone concentration after deployment from an Arcas rocket vehicle. A sample bottle empties as it is carried to low pressures of high altitudes and is ejected above the stratopause level. Flow into the bottle results from the differential pressure as the instrument descends on a drag parachute. Ozone in the environment flows over the detector and the photons produced by the destruction of ozone molecules on the chemiluminescent material are monitored by a photomultiplier tube. The output signal is transmitted on a carrier frequency of 1680 megacycles and received at the ground by an/gmd-1 equipment, the instrument is calibrated with known concentrations of ozone and flow rate. Results of one firing are presented. Author (TAB)

**N67-14897*#** Douglas Aircraft Co., Inc., Newport Beach, Calif. Astropower Lab.

**DESIGN STUDY OF A CLOUD PATTERN RECOGNITION SYSTEM Final Report, 15 Jun. 1964–15 Sep. 1965**

15 Sep. 1965 231 p refs

(Contract NAS5-3666)

(NASA-CR-80963; SM-46215-F) CFSTI: HC $3.00/MF $2.60 CSCL 14E

A design technique for pattern recognition and its application to TIROS photographs is presented. Other aspects of the technique were investigated in a series of experiments on alphabetic characters. In the case of alphabetic characters, the design techniques provided networks giving perfect separation of the sample patterns with a small number of property filters. The generalization performance of these networks was good in comparison with classification systems produced using several other design techniques. A method for building invariance to linear changes in the gray scale into the property filters is developed. Optical studies to determine the resolution necessary for untrained observers to classify vortex patterns in TIROS frames were conducted. Networks were designed to separate a sample of 1000 high-resolution TIROS frames. The technique provided perfect separation of the sample patterns with a very limited set of property filters—about 240. Means for improving these results by normalization of the patterns and by some decoupling of the design technique are suggested. S.P.

**N67-14917*#** Melpar, Inc., Falls Church, Va.

**HAZARDS MONITORING AT NASA MERRITT ISLAND LAUNCH AREA. VOLUME IV, TASK D: MEASUREMENTS OF INCIDENT AND REFLECTED UV AND IR ELECTROMAGNETIC BACKGROUND AT SATURN COMPLEX Final Report**

Nov. 1965 80 p refs

(Contract NAS10-2009)

(NASA-CR-80957) CFSTI: HC $3.00/MF $1.30 CSCL 14B

The results of incident and reflected ultraviolet and infrared spectrum measurements of the background radiation environment at the Saturn Complex at Kennedy Space Center in which a hydrogen detector would have to operate, are presented. The data curves indicate that the daytime ultraviolet background is several orders of magnitude above the brightest hydroxyl lines which occur near 3100 A. A system which seeks to detect, by virtue of radiant contrast in this spectral region, a small flame in a background of strong sunlight appears infeasible. Quantitative measurements of the radiation from hydrogen-air flames at wavelengths shorter than 3000 Å were limited by the detection limits of the system as well as by overlapping of the visible spectrum, which precluded radiant calibration in this region. The infrared data indicate that hydrogen flame detection in the presence of a bright natural background is feasible in the atmospheric water absorption bands. Instrumentation used for the measurements; calibration standards; measurement procedures used; and procedures for data collection and reductions, are described. Data on natural ultraviolet irradiance at sea level and a table of spectral radiance standards are given. L.S.

**N67-15025#** Elcon Lab., Inc., Salem, Mass.

**MEASUREMENT OF ATMOSPHERIC EXTINCTION AND LIGHT SCATTERING FUNCTION. PART I: POLAR NEPHELOMETER AND POWER SUPPLY Final Report, May 1963–May 1966**

Griffith Resor, III Jul. 1966 105 p

(Contract DA-36-039-AMC-02256(E))

(R-3-66-2; ECOM-02256-F, Pt. I; AD-637795) CFSTI: HC $4.00/MF $0.75

An ultraviolet polar nephelometer which is used to measure the differential scatter function of air is described. The instrument covers the range from pure air to dense haze conditions. The report gives a comprehensive discussion of the design of

the instrument, detailed description of the optical and electrical components, installation procedures, and maintenance guide. The nephelometer has a useful, dynamic range of 60 db, adjusted so that adequate signal is obtained for pure air. Detailed specifications are listed. Author (TAB)

N67-15037# Army Nuclear Defense Lab., Edgewood Arsenal, Md.
**MOSSBAUER-EFFECT SPECTROSCOPY**
A. A. Temperley Oct. 1966 36 p refs
(NDL-TM-33; AD-640318) CFSTI: HC$2.00/MF$0.50

Mossbauer-effect spectroscopy is discussed with emphasis on spectrometer design. Construction of a Mossbauer-effect spectrometer using a loudspeaker as the velocity transducer, capable of operation with either constant velocities or with constant accelerations, is described. Resonance experiments with the 14.4-keV Mossbauer-effect gamma ray from Co57 (Fe57m) are used to describe the performance of the spectrometer. Author (TAB)

N67-15041# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**DIRECT HEATING RELAXER**
L. N. Aleksandrov and V. S. Mordyuk 30 Mar. 1966 14 p refs Transl. into ENGLISH of the book "Trudy Vsesoyuznaya Konferentsiya po Relaksatsionnym Yavleniyam v Metallakh i Splavakh" Moscow, Metallurgizdat, 1963 p 65–71
(FTD-TT-65-1637; TT-66-62461; AD-640477) CFSTI: HC $1.00/MF$0.50

Translation of Russian research: direct heating relaxer. TAB

N67-15077# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**DEVICE FOR MULTIPLE-POINT MEASUREMENT OF TEMPERATURE**
S. P. Mazur 28 Jun. 1966 6 p Transl. into ENGLISH from Russian Patent No. 168497 (Appl. No. 868924/26-10, 4 Dec. 1963) 2 p
(FTD-TT-65-1937; AD-638872) CFSTI: HC$1.00/MF$0.50

The object of the invention is a device for multiple-point measurement of temperature with the aid of a thermocouple included in the circuit of a potentiometer with a change-over switch. Thermocouples are connected to a potentiometer through a junction box in accordance with the scheme: thermocouple - junction box - change-over switch of the potentiometer - slip rings of the change-over switch-junction box - terminal of the potentiometer, while the compensation wire is extended only on the first and last sections. TAB

N67-15112# Army Engineer Geodesy, Intelligence and Mapping Research and Development Agency, Fort Belvoir, Va.
**PRACTICAL FIELD ACCURACY LIMITS FOR A WILD T-2 THEODOLITE Technical Report, 11 Oct.–14 Nov. 1965**
Peter J. Cervarich, II Aug. 1966 157 p
(Rept.-30-TR; AD-642295) CFSTI: HC$3.00/MF$0.65

The report covers the results of field tests of the wild T-2 theodolite performed to determine the field accuracy limits of this instrument, thereby establishing the design goal for an all-weather angle-measuring instrument under consideration. Analyses of data indicate that this particular test instrument is capable of measuring an angle 90 percent of the time to an accuracy of plus or minus 2."5 when 16 D and R readings are observed during daylight hours; the accuracy of angular measurement is plus or minus 2."0 during nighttime, 90 percent of the time; and the accuracy limits are reduced from plus or minus 2."5 to plus or minus 2."0 and from plus or minus 2."0 to plus or minus 1."5 if data are gathered when the atmosphere is 'quiet.' The report concludes that angular accuracy is not improved by employing 'horizon closure' techniques, and that proper selection of the survey sites is one of the more important factors to consider when the mission requires high accuracy. Author (TAB)

N67-15212*# Melpar, Inc., Falls Church, Va.
**HAZARDS MONITORING AT NASA MERRITT ISLAND LAUNCH AREA. VOLUME II: TASK B–ULTRASONIC LEAK DETECTORS FOR CRYOGENICS AND GASES Final Report**
Nov. 1965 64 p refs
(Contract NAS10-2009)
(NASA-CR-81124) CFSTI: HC$3.00/MF$1.30 CSCL 14B

The performance and applicability of ultrasonic leak detectors for cryogenics and gases are reported, and details are given on laboratory tests and evaluation, acoustic analysis, specification compliance and deviations, and calculation of leak rate and dispersion of gaseous hydrogen. Tests run to determine the variability of leak noise as a function of leak geometry, pressure, angle from the axis of the leak, and the gas involved are described. Details are also given on tests conducted in conjunction with Saturn transfer and checkout operations to determine noise and interference background generated by ground service equipment. The ultrasonic spectrum recorded and analyzed was in the range 20 to 50 kc, and the analyzer filter bandwidth used in data reduction was less than 500 cps at the 3 db point. Test results are given, and suggested modifications to the ultrasonic leak detectors are included. L.E.W.

N67-15251*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
**GRAPHIC SUMMARY OF THE RESPONSES OF THE UNIVERSITY OF IOWA CHARGED PARTICLE DETECTORS ON EXPLORER 14**
L. A. Frank, R. C. Bohlin, and I. L. Mc Clain Sep. 1966 403 p refs
(Grant NSG-233)
(NASA-CR-81141; Rept.-66-40) CFSTI: HC $3.00/MF $3.90 CSCL 14B

Graphs of the responses of the charged particle detectors borne on Explorer 14 are displayed for the period extending from launch on 2 October 1962 through 9 August 1963 when transmission of data terminated. This graphic summary provides a convenient abridged dictionary of available data and serves as a useful guide for further processing of these data. Author

N67-15254*# Aracon Geophysics Co., Concord, Mass.
**MANUAL GRIDDING OF RIR FACSIMILE PICTURES**
Robert B. Smith Nov. 1965 30 p refs
(Contract NAS5-3253)
(NASA-CR-81132; DOC.-9237-44; TN-7) CFSTI: HC $3.00/MF $0.65 CSCL 14E

A method is presented for manual geographical referencing of direct Readout Infrared Radiometer (DRIR) data from the Nimbus C meteorological satellite, assuming no satellite attitude error. The procedure leads to geographically referenced DRIR data, with labeled five degree latitude and a longitude lines drawn at the correct locations. The method requires the use of one of a set of three transparent latitude–longitude grids. The grids have fixed latitudes, at five degree intervals. Unassigned longitude lines are also at five degree intervals, except at latitudes greater than 60°, where, due to convergence of the meridians, the interval is greater. Absolute values of longitude are determined by reference to the longitude of the subsatellite track of a particular orbit. By suitable rotation and/or inversion, the grids may be used for both the northern and southern hemispheres, and for either southbound or northbound passes. Author

N67-15276# Ballistic Research Labs., Aberdeen Proving Ground, Md.
**PRESSURE SCANNER UNIT**
Raymond Colburn Jun. 1966 21 p
(BRL-TN-1616; AD-640206) CFSTI: HC$1.00/MF$0.50

A pressure scanner unit, capable of receiving a relatively large number of pressures and transmitting them to a small number of transducers for recording, has been developed at the Ballistic Research Laboratories. The air-operated unit also provides the facility for checking all pressure leads and connections, and providing a reference vacuum (or pressure) for transducer calibration. The unit presents prototype for pressure scanners of any capacity. Author (TAB)

# 15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N67-14364# Joint Publications Research Service, Washington, D. C.
**SOME OPTIMAL CONDITIONS OF HEATING A METAL**
S. A. Malyy *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 243-250 refs (See N67-14341 05-10)

To determine the economic indices of production, the variation method and the maximum principle are used to calculate optimal conditions of heating a metal before rolling. Two cases are considered: the problem of maximizing profits, and of heating with minimum oxidation. M.G.J.

N67-14520*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**DEVELOPMENT OF AN ELECTRODEPOSITION PROCESS FOR THE FABRICATION OF A SPHERICAL CRYOGENIC FLUID STORAGE CONTAINER**
R. N. Hanson and B. K. Davis 15 Aug. 1966 29 p
(NASA-TM-X-53502) CFSTI: HC$2.00/MF$0.50 CSCL 13H

A 51-inch diameter, electrodeposited nickel, spherical pressure vessel was successfully designed, fabricated, and tested. The vessel was fabricated by depositing nickel on an aluminum mandrel in a nickel sulfamate electroforming bath. The aluminum mandrel was removed after completion of the electroforming process by chemical etching with dilute hydrochloric acid. A hydrostatic proof test and helium leak test showed that the vessel meets the following design requirements: operating pressure, 50 psig; proof pressure, 70 psig; and helium permeability, less than $10^{-6}$ std/cc/sdc/ft$^2$. Author

N67-14532*# Ministry of International Trade and Industry, Tokyo (Japan). Machining Technology Section.
**SEVERAL TYPES OF CHIP FORMATION IN PLASTICS MACHINING**
Akira Kobayashi *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 163-201 refs (See N67-14521 05-34) CFSTI: HC$6.87/MF$2.50

Fracture phenomena in plastics cutting are discussed with regard to types of chips, deformation of work material, magnitude, and direction of cutting forces during cutting, and also rheological effects on the cutting mechanism. Five types of chips are obtained in cutting several kinds of plastics, which are classified into continuous and discontinuous types. The former is subdivided into two kinds: the continuous flow and the continuous shear. The continuous flow type chip is produced by high elastic deformation which does not occur in metal cutting, in contrast to the continuous shear type chip which is a product of slippage by shear stress which is similar to metal cutting. The discontinuous type chips are subdivided into two kinds: discontinuous shear and discontinuous crack type. The former is produced by plastic fracture through simple shear or complex shear, and the latter is formed by brittle fracture, namely elastic fracture. Chip types vary with not only the kinds of plastics but also the cutting conditions. The variations of the chip formation mechanism with the cutting speed and work temperature are explained through the rheological behavior of plastics. Author

N67-14534*# Institute of Physical and Chemical Research, Tokyo (Japan).
**AN ANOMALOUS FLOW DURING ROLLING OF VISCOUS MATERIALS**
Toshimaro Sone, Masayoshi Fukushima (Snow Brand Milk Prod. Co.), and Eiichi Fukada *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 227-239 refs (See N67-14521 05-34) CFSTI: HC$6.87/MF$2.50

A regular striped pattern has been observed in viscous liquids during rolling. The stripes run in the direction of rotation of the roller and with the same distance between peaks. The number of peaks increases discontinuously with the decrease of viscosity, lowering of clearance, and increase of roller speed. At the outlet from the clearance, stripe patterns with saddles have been observed. The height of the saddle is correlated with the Maxwellian relaxation time of the liquids. The peaks in the pattern are a continuation of the saddles and the height is determined by the centrifugal force and viscoelastic properties of the liquids. The reason for regular spacing of stripes is still unexplained. Author

N67-14678# Marine Engineering Lab., Annapolis, Md.
**MECHANICAL SHOCK RESISTANCE OF THREADED FASTENERS**
John R. Braden and Richard E. Heise, Jr. Oct. 1966 36 p refs
(MEL-412/66; AD-639953) CFSTI: HC$2.00/MF$0.50

An investigation was made of the mechanical shock resistance of K-Monel full-body studs set in HY-80 steel under various conditions. Strain gages mounted on the stud shanks were used to measure dynamic loading. Elastic nylon-insert monel stop nuts were used throughout the test. The data indicated that for the conditions of the test Locktite-coated 3A-3B threads are equal in shock resistance to uncoated 5A-5B threads, and that the elastic stop nuts are reusable after repeated shock. Author (TAB)

N67-14693# Nuclear Materials and Equipment Corp., Apollo, Pa.
**GROWTH OF SINGLE CRYSTALS OF PLUTONIUM Quarterly Progress Report, 1 Jan.-30 Mar. 1966**
29 Apr. 1966 17 p refs
(Contract AT(30-1)-3428)
(NUMEC-3428-21) CFSTI: HC$1.00/MF$0.50

Efforts directed toward setting up zone melting equipment to determine the feasibility of zone refining C-contaminated Pu-Ga alloy rods and to evaluate the potential of zone refining as a means of producing single-crystal delta Pu are described. Results of chemical analyses of zone refined material show that zone melting did not result in transport of impurities along the rod. Strain anneal and secondary recrystallization were selected as the methods for use in delta stabilized Pu single-crystal studies. NSA

N67-14696# Chantiers de l'Atlantique Penhoet-Loire, Paris (France).
**APPLICATION OF THE SUBMERGED ARC WELDING PROCESS TO THICK PLATES Quarterly Report, 1 Apr.-30 Jun. 1966**

C. Leymonie 7 Jul. 1966 6 p
(Contract EURATOM-054-61-02 RDF)
(EURAEC-1684; DUR-2871; QR-5) CFSTI: HC$1.00/MF$0.50

Results of investigations are discussed concerning austenization, dilatometry, and stress relief in steels designated as 15 MDV, 1.2 MD 07, Wel-Monix, WB 35, and PM 24. NSA

N67-14707# Springfield Armory, Mass.
**DEVELOPMENTS IN THE HARMONIC ANALYSIS METHOD FOR THE NONDESTRUCTIVE DETERMINATION OF CASE DEPTH OF CARBURIZED STEEL**
H. P. Hatch and K. A. Fowler 20 May 1966 26 p refs
(SA-TR19-1520; AD-640052) CFSTI: HC$2.00/MF$0.50

The investigation concerned with the nondestructive determination of case depth of carburized steel by the harmonic analysis method was continued. The test method and instrumentation used in this investigation were described in detail in a previous Springfield Armory Technical Report, SA-TR19-1514 (AD-626 602). The harmonic analysis instrument developed previously in the program was utilized to study the effect of sample dimensions, chemical analysis, and the feasibility of employing a probe-type test coil. Results of this investigation demonstrated that the method was effective for measuring deep cases through .075 inch and shallow cases on samples having small cross-sectional areas. The effect of the demagnetizing factor was found to influence only the sensitivity of results, and substantial variations in alloying elements produced only minor differences in harmonic measurements. Correlation between case depth and harmonic phase shift was similar on samples heat-treated by either the gas or liquid-carburizing process. The ability to use a probe-type test coil for measuring case depth by this method was demonstrated by a prototype design. Author (TAB)

N67-14738# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**MULTIPOSITION MACHINE FOR TESTING FLAT SPECIMENS FOR FATIGUE**
A. S. Nikishov, I. A. Yarov et al 18 Apr. 1966 9 p Transl. into ENGLISH from Russian Patent No. 167055 (Appl. No. 840633/25-8, 8 Jun. 1963) 3 p
(FTD-TT-65-1391; AD-640472) CFSTI: HC$1.00/MF$0.50

The object of the invention is a multiposition machine for testing flat specimens for fatigue with sign-varying (between plus and minus) bending consisting of a ring-shaped vibrator with changeable cam disks for creating in each specimen varying stresses which vary in magnitude, and an electric heater for heating the specimens being tested. For the purpose of changing the specimens being tested without stopping the machine, it is provided with removable tail spindles radially arranged around a ring-shaped vibrator and which serve for fastening the specimens that are being tested. Author (TAB)

N67-14794*# General Electric Co., New York.
**MANUFACTURING AND HANDLING PROCEDURES FOR PLANETARY SPACECRAFT WHICH ARE TO BE STERILIZED BY HEATING**
Frederick J. Beyerle (NASA, Marshall Space Flight Center) and Harold G. Lorsch *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 515-541 ref (See N67-14761 05-05)
GPO: HC$2.25; CFSTI: MF$2.50
(Contract NAS8-11372)

Progress is reported on the preparation of procedures for the manufacture, assembly, and handling of typical planetary spacecraft which are to be heat sterilized. The procedures cover the full cycle of the spacecraft from the receipt of raw material through vendor procurement, manufacture, assembly, test, transportation, sterilization, checkout, and prelaunch. Two operations subsidiary to a spacecraft pilot assembly operation were performed. One consisted of elementary electrical assembly operations both at a standard workbench and inside a glove box, with comparison of the times required. The other consisted of assembling an electrical module under a variety of bioclean conditions and comparing the levels of biological contamination. Two types of flexible wall clean enclosures are described and the particulate and biological contamination of each enclosure was determined and compared with requirements. Also included are a cost comparison of clean rooms, and discussions of vendor requirements, contractor responsibilities, assurance of vendor quality and biocleanliness, and vendor problems. R.N.A.

N67-14802 California Univ., Berkeley.
**SOME RECENT DEVELOPMENTS IN ENGINEERING MATERIALS AND PROCESSES**
Earl R. Parker *In* Agr. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 20 p refs (See N67-14801 05-17) CFSTI: HC $7.30/MF $2.00

The processes covered in this paper are casting and joining by welding and by adhesives. The new welding methods discussed are electron beam, friction, ultrasonic, explosive and laser welding. The increasing use of resins, specially epoxy resins, and their advantages and limitations is discussed. The lack of important developments in the field of casting processes is pointed out while a brief mention is made of the combined use of casting and die forging and of the addition of powdered ferrosilicon to molds for nodular cast iron to increase graphitization in thin sections. In the area of new materials emphasis is placed on high strength structural steels, ausforming and maraging steels, high strength titanium alloys, composite glass-resin structures, and chemically and thermally treated glasses. Author

N67-14803 Universidad de la Republica, Montevideo (Uruguay). Facultad de Ingeniera.
**DEVELOPMENT AND PLAN OF ACTIVITIES OF THE CASTING LABORATORY AT THE METALS DEPARTMENT OF THE CHEMISTRY AND TECHNOLOGY INSTITUTE OF THE SCHOOL OF ENGINEERING OF THE UNIVERSITY OF URUGUAY [DESARROLLO Y PLAN DE ACTIVIDADES DEL LABORATORIO DE FUNDICION DEL INSTITUTO DE TECHNOLOGIA Y QUIMICA DE LA FACULTAD DE INGENIERIA Y AGRIMENSURA DE LA UNIVERSIDAD DE LA REPUBLICA ORIENTAL DEL URUGUAY]**
Alfonso Gaggero and Blas Melissari *In* Arg. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 15 p In SPANISH; ENGLISH summary (See N67-14801 05-17) CFSTI: HC$7.30/MF$2.00

The present status of the casting industries in Uruguay are analyzed first. It is concluded that the lack of adequate technical assistance creates many inconveniences which could be avoided by centralizing all efforts at the Casting Laboratories. The German government has helped to develop these laboratories by furnishing equipment and experts. Present activities are now carried out in the fields of molding sands quality control, adapting new methods to local conditions, and training of personnel. Author

N67-14813 Air Force Systems Command, Wright-Patterson AFB, Ohio. Materials Lab.
**PROBLEMS AND DEVELOPMENTS IN PRIMARY PROCESSING OF REFRACTORY METALS**
Thomas D. Cooper and Vincent de Pierre *In* Arg. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 28 p refs (See N67-14801 05-17) CFSTI: HC$7.30/MF$2.00

After a brief review of the status of the refractory metal technology the paper presents several of the more important accomplishments in the melting and primary extrusion of refractory

metals. The purpose is to indicate the progress that has been made in primary processing and also to stimulate thought as to the general application of the results to the metallurgical processing of other materials. Of all the factors controlling ingot quality only those variables affecting grain size and the problem of ingot cracking are considered. A new and extremely useful technique has been developed to measure die loads during extrusion. With it, optimum conditions for extrusion can be determined and predictions can be made as to the proper extrusion conditions for an alloy, from appropriate mechanical property data. Author

N67-14818*# General Precision, Inc., Glendale, Calif. Librascope Group.
**STUDY OF COLD-SUBSTRATE DEPOSITION OF THIN FILM PASSIVE ELEMENTS Final Report**
Oct. 1966 85 p
(Contract NAS12-109)
(NASA-CR-80915) CFSTI: HC $3.00/MF $0.75 CSCL 13H

This program is a feasibility study of the fabrication of thin film passive elements by the cold substrate deposition process. The thin film passive elements referred to are resistors and capacitors. Cold substrate deposition is a unique film forming process. A number of benefits are inherent in this process. Two of particular importance to this program are (1) the ability to form a very thin film of high integrity, and (2) the tenacious bonding that is obtained between deposited film and substrate, achievable with a wide variety of materials systems without increasing the temperature of the bulk substrate above room ambient. The goals of this program are to demonstrate that the process can be used to advantage to form arrays of resistors ranging from $10^2$ to $10^5$ ohms per square, and arrays of capacitors of 60,000 pico-farads per square inch. Such devices were successfully prepared, and have electrical properties which demonstrate the potential advantages of the process in this area of application. Author

N67-14918*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
**LOW TORQUE THREE-PIECE VALVE SEAT**
15 Sep. 1966 19 p
(NASA-TM-X-59266; TR-426) CFSTI: HC $3.00/MF $0.65 CSCL 13K

Visual inspection, hydroproof, pneumatic proof, cycle, and seat erosion qualification tests were performed on three specimen low torque three-piece valve seats. The design geometry and materials of the specimens were identical except that upper seat ring (B) was fabricated from Teflon for specimen no. 1, Nylon for specimen no. 2, and Kel-F for specimen no. 3. The lower seat ring (C) was fabricated from Teflon for all three specimens. The tabulated test results indicate that all three specimens successfully demonstrated a capability to seat under cyclic and seat erosive conditions at 6000 psig pneumatic working pressures, and to withstand pneumatic proof pressures across the seat of 10,000 psig. The results show that a variety of materials can be used successfully for seating materials, such as soft metals and various grades of plastics, thus permitting the selection of seating material to be based on design factors such as system compatibility, temperature, and strength. L.S.

N67-14920*# Avco Corp., Wilmington, Mass. Space Systems Div.
**INVESTIGATION OF 3-D FABRICATION OF ABLATIVE MATERIALS Final Report, 8 Sep. 1965–18 Oct. 1966**
Nov. 1966 265 p refs
(Contract NAS9-5207)
(NASA-CR-65560; AVSSD-0308-66-RR) CFSTI: HC $3.00/MF $2.60 CSCL 13H

The fabrication and properties of three dimensionally reinforced ablative materials having no planes of weakness are investigated. Nine methods of state-of-the-art fabric production were compared on the basis of 1) ease of fabrication, 2) amount of machine modification necessary to make 8 inch thick fabric, and 3) the maximum thickness capability based on present industry know how. Thermal, physical, and mechanical properties of these fabrics as composites with epoxy resin were determined and compared. Three methods, Avco 3-D, double-loop fabric as laminates, and needling can produce the required billet sizes for nozzle fabrication without further large scale development. These methods have produced marked improvement in thermal shock resistance and interlaminar strength over conventional laminates. Experimental thruster test chambers were fabricated with three variations of Avco 3-D fabric for test firing as a start on a property-performance correlation. L.S.

N67-14969# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**WAVE METHOD OF CALCULATING IMPULSE LOADS OF TURBINE BLADES**
A. A. Moiseyev, A. A. Petrov, and O. I. Mikhaylov 25 Apr. 1966 10 p refs Transl. into ENGLISH from Sudostroyeniye (Leningrad), no. 11, 1964 p 33–34
(FTD-TT-65-1990; TT-66-62433; AD-640291) CFSTI: HC $1.00/MF $0.50

The linear dependency between dynamic stresses in rotor blades and the accelerations of the elastic vibrations in the rotor, the body, and the base of the turbines is analyzed by calculating the elastic impulse wave loads on the blades at any point and at any moment of time. The influences of temperature, partial quality of the intake, fading out, rigidity, time of application, removal of load on the blades, flutter, etc., are considered in computations for blade design. Maximum values for the intersecting forces under impulse loads are computed by the wave method in accordance with the Timoshenko equations and solutions are obtained through expansion of the function with the degrees of the basic natural logarithms. G.G.

N67-14970# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**HIGH-SPEED STAMPING OUT OF METALS**
Yu. P. Sogrishin and N. F. Koyakovskiy 6 Apr. 1966 11 p Transl. into ENGLISH from Byull. Tekh.-Ekon. Informatsii (Moscow), no. 9, 1964 p 25–28
(FTD-TT-65-1372; TT-66-62427; AD-640285) CFSTI: HC $1.00/MF $0.50

Described is an automatic machine for high-speed volume stamping-out of stock pieces from ordinary metals and alloys into precision shapes. The machine consists of a hydraulic drive, the gas tank station, and the control desk that controls the rod with the sliding block, having an impact force of up to 16 tm at a speed of 20 m/sec. Most of the forgings are finished by one impact; the best shaping is obtained when the direction of the flow of the metal coincides with the direction of the impact. G.G.

N67-14982# Frankford Arsenal, Philadelphia, Pa. Fire Control Development and Engineering Labs.
**THE ACOUSTIC ANALYSIS OF MATERIALS IN DYNAMIC APPLICATIONS**
Thomas J. Downing Sep. 1966 36 p refs
(M67-8-1; AD-641720) CFSTI: HC $2.00/MF $0.50

The sound spectrograph, which plots a pattern showing signal energy level variation in both frequency and time, was utilized as the primary analysis equipment during this period. To produce a meaningful pattern, magnetic tape slow-down methods and special signal handling electronics were employed for spectrogram axis scale control and time-displacement referencing. Spectrographic patterns were made for comparative analyses of proper and defective (tooth missing) gear train operation. Significantly different patterns were obtained demonstrating that effects hidden in the

waveform become very evident in the pattern. Sound spectrography is exploited fully in the analysis of system characteristics where either fixed excitation is operated on by a time-varying transfer function, or controlled excitation having time-varying spectral content is applied to a fixed transfer function. The former class includes all rotational and reciprocating equipment and equipment powered by periodic excitation. The latter class includes all passive (no moving parts) devices excited by programmed forcing functions. Author (TAB)

N67-14989# Army Materials Research Agency, Watertown, Mass.
**HIGH SPEED DEFORMATION OF SELECTED HIGH-STRENGTH ALLOYS: EFFECT ON MECHANICAL PROPERTIES**
Robert M. Colton and Roger A. Gagne Aug. 1966 20 p refs
(AMRA-TR-66-23; AD-640023) CFSTI: HC $1.00/MF $0.50

The effect of deformation rate and temperature on the as-formed and heat-treated mechanical properties of Ti-6A1-4V and Ti-6A1-6V-2Sn were determined. In general, heat treatment removes any effect of deformation rate or temperature on the mechanical properties of both alloys, except at forming temperatures above their respective beta-transus temperature, where embrittlement is observed. The effect of strain rate on the mechanical properties is slight for Ti-6A1-4V, and quite noticeable for Ti-6A1-6V-2Sn in the as-formed condition at each forming temperature. In general, strength and ductility decrease in the as-formed condition for both alloys as the forming temperature increases for both strain rates evaluated. Author (TAB)

N67-15023# National Academy of Sciences–National Research Council, Washington, D. C. Materials Advisory Board.
**AD HOC COMMITTEE ON METALWORKING PROCESSES AND EQUIPMENT Progress Report, Oct. 1965–Jun. 1966**
Sep. 1966 25 p
(Contract DA-49-083-OSA-3131)
(MAB-206-M(4); PR-4; AD-640230) CFSTI: HC $1.00/MF $0.50

Topics included are: (A) The use of the computer in forging die design. (B) The use of model experiments in forging die design. (C) The application of plasticity mechanics to forging die design. TAB

N67-15030# National Academy of Sciences–National Research Council, Washington, D. C. Materials Advisory Board.
**CHARACTERIZATION OF BERYLLIUM**
Aug. 1966 19 p ref
(Contract DA-49-083-OSA-313)
(MAB-226-M; AD-640210) CFSTI: HC $1.00/MF $0.50

The report compiles the major process variables corresponding to the principal operations gone through in producing a beryllium mill product, and then a part. This compilation comprises a check list which should be reviewed at the start of a research or development effort to ensure that variables which might be significant are not being overlooked. The ultimate object of compiling and studying such data is to assure uniformity, and thus introduce reliability into manufactured parts. Author (TAB)

N67-15078# Naval Applied Science Lab., Brooklyn, N. Y.
**METHODS FOR STRIPPING COATED ANODES Progress Report**
I. Geld and S. H. Davang 3 Oct. 1966 12 p refs
(PR-1; AD-639963) CFSTI: HC $1.00/MF $0.50

Occasionally, platinum anodes are inadvertently painted, rendering them inoperative. Paint removal by abrasive blasting may erode the soft platinum. Electrolytic methods for stripping the Navy underwater vinyl paint system were found ineffective at applied potentials up to 20 volts and anode current densities up to about 3000 amperes per square foot. Solvents which removed vinyl paint quickly were acetone, toluene, methylene chloride, MEK, MIBK, and Trichloroethylene. Author (TAB)

N67-15159*# Sunrise Aircraft Corp. of America, La Mesa, Calif.
**DEVELOPMENT OF A HOT JET PUMP BLC SYSTEM (JET INDUCED LIFT SYSTEM). PHASE I: BENCH TESTING OF AN EXPERIMENTAL JET PUMP**
Randall J. Seaver [1966] 99 p refs
(Contract NAS2-2518)
(NASA-CR-73046) CFSTI: HC $3.00/MF $1.30 CSCL 13K

Bench testing is reported for an experimental jet pump that uses high energy compressed air as a driving fluid, has a configuration typical of requirements for a jet-induced high-lift wing system, and uses suction and blowing to control boundary layer. Maximum primary jet total pressure was 410 psia, maximum total temperature at the nozzle throat was 2590°F, and induced airflow up to 2.444 lb/sec was measured. Mass augmentation ratio for this induced suction flow was 22.2; at a low blowing slot airflow, however, maximum mass augmentation was 28.9. Maximum thrust augmentation was 1.32. Jet pump performance was adversely affected by total pressure losses caused by an unstreamlined primary jet feedpipe and nozzle cluster obstruction in the suction duct, and by duct wall flow separation in the blowing duct. Wooden inserts in the suction and blowing ducts improved both duct flow and loss characteristics. Improved performance resulted from the decrease in total pressure loss. Test results support the use of a high lift multiple jet pump system for boundary control in short takeoff and landing (STOL) aircraft. M.W.R.

N67-15171# Joint Publications Research Service, Washington, D. C.
**MANUFACTURE OF PISTONS FOR HIGH-SPEED ENGINES USING SINTERED ALUMINUM POWDER (SAP)**
B. I. Matveyev 12 Jan. 1967 5 p refs Transl. into ENGLISH from Vestn. Mashinostr. (Moscow), no. 11, Nov. 1966 p 46–47
(JPRS-39514; TT-67-30164)

The technique for manufacturing Sintered Aluminum Powder (SAP) pistons is described and the mechanical properties of this material are given. It is noted that the valuable property of the SAP material is the fact that it does not change its characteristics at temperatures of 500–550°C and with prolonged heating up to 10,000 hours. A.G.O.

N67-15215*# General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section.
**MATERIALS FOR POTASSIUM LUBRICATED JOURNAL BEARINGS Quarterly Progress Report, 22 Jan.–22 Apr. 1966**
R. G. Frank, ed. 22 Apr. 1966 192 p refs
(Contract NAS3-2534)
(NASA-CR-72041; QPR-12) CFSTI: HC $3.00/MF $1.95 CSCL 13H

The first test assembly on materials for potassium lubricated journal bearings was completed for a test utilizing unlubricated angular contact ball bearings in a wear testar. Potassium flow over the disc specimen was verified visually at 1,000 RPM. Thirty-five friction and wear tests were conducted in the high vacuum friction and wear tester on several candidate bearing material combinations at RT 400°, 800°, and 1200°F, at pressures of $10^{-9}$ torr, and at speeds of 800 SFM. Thirty-eight elevated temperature compression tests comprising ten candidate bearing materials were conducted in a vacuum of $10^{-9}$ torr and at temperatures up to 1600°F. Technical data are included for potassium friction and wear tester arm calibration and specimen testing procedure, as well as for high vacuum friction and wear data. R.U.

N67-15216*# General Precision, Inc., Little Falls, N. J. Aerospace Research Center.
**RESEARCH ON MATERIALS FOR GAS-LUBRICATED GYRO BEARINGS Technical Summary Report, 1 Dec. 1965–31 Aug. 1966**

John L. Rutherford and William B. Swain 31 Oct. 1966 140 p
(Contract NAS12-90)
(NASA-CR-80000; TSR-1) CFSTI: HC $3.00/MF $1.95 CSCL 13H

To develop improved materials for hydrodynamic gyro gas bearings, a comprehensive study of the friction, wear, and dimensional stability characteristics of a selected group of ceramics was undertaken. The materials included: high density $Al_2O_3$ (Lucalox), cemented $Al_2O_3$ (Carboloy), hot-pressed $Al_2O_3$, plasma-arc deposited $Al_2O_3$ on a Be substrate, and hot-pressed BeO. The surfaces of each material were fully characterized before and after testing. A special test rig for measuring friction and wear properties was constructed. The coefficient of friction and the damage mechanisms and extent were found to be strongly influenced by the surface structure. New, improved machining techniques were developed which enhanced the friction and wear properties. Lubricants were found to be detrimental to these properties. Dimensional changes under zero and applied load were made at extension sensitivities on the order of $10^{-6}$ inches. Based on these results, Lucalox, Carboloy and plasma-arc deposited $Al_2O_3$ are most promising for gyro gas bearing applications.

Author

**N67-15217*#** General Electric Co., Cincinnati, Ohio. Research and Development Center.
**HYDRODYNAMIC JOURNAL BEARING PROGRAM Quarterly Progress Report, 29 Oct. 1965–29 Jan. 1966**
J. D. McHugh, H. E. Nichols, and W. D. C. Richards 18 Apr. 1966 127 p refs
(Contract NAS3-6479)
(NASA-CR-72034; QPR-3) CFSTI: HC $3.00/MF $1.95 CSCL 13I

The results of the dynamic evaluation testing of proximity probes (when provided with a teflon cap to shield against water) are presented. Also, the results of the dynamic loader bearing friction torque calibration are included. In addition, the force gauges which support the test bearings have been calibrated on a special test rig operated to 7000 rpm. Manufacture of the main test rig for this program has been completed and all parts received. Design of a self-aligning pivoted pad bearing is in progress. A critical speed analysis of the test rig for test-planning purposes has been completed.

Author

**N67-15255*#** Vitro Labs., West Orange, N. J.
**ELECTROPHORETIC DEPOSITION OF METAL-BONDED MOLYBDENUM DISULFIDE FOR GEAR LUBRICATION Final Report, 17 Jun. 1965–31 May 1966**
31 May 1966 48 p refs
(Contract NAS5-9623)
(NASA-CR-81133) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The electrophoretic deposition technique was adapted to the coating of Type 303 stainless steel test pins, test discs, and worm gears with codeposited solid lubricant films containing 20 volume % $MoS_2$ plus Monel or silver–copper eutectic. In Falex tests, the silver–copper bonded film exhibited better adherence than the Monel bonded composition and sustained loads of up to 140 lbs. with a coefficient of friction of 0.05 or less when run against uncoated C1137 steel "V" blocks (20–25 Rc) at 290 rpm. In pin and disc sliding friction tests, the best of the Ag–Cu bonded coatings maintained a coefficient of friction of less than 0.3 for 60 hours when rubbed against an uncoated bronze sphere at a normal load of 60 grams and a speed of 4 fpm. The best of the Monel bonded films ran a total of 96 hours with a coefficient of less than 0.3 under the same load and at a speed of 40 fpm. Both films were rapidly when the normal load was increased to 600 grams. A set of 16 single thread, right hand, 0.3333 in pitch diameter, Type 303 stainless worm gears were coated with each of the lubricant films.

Author

**N67-15279*#** North American Aviation, Inc., Los Angeles, Calif.
**DEVELOPMENT OF NONDESTRUCTIVE TESTING TECHNIQUES FOR HONEYCOMB HEAT SHIELDS, VOLUME I Final Report, 1 Jul. 1964–29 Sep. 1966**
George Martin and J. F. Moore 15 Nov. 1966 167 p refs
(Contract NAS8-11733)
(NASA-CR-81145; NA-66-912, Vol. I) CFSTI: HC $3.00/MF $2.60 CSCL 13H

The development of a portable nondestructive testing and scanning/recording system, using ultrasonic techniques, for the detection of disbonds in composite honeycomb structures by inspection methods operating from one side only of the honeycomb is described. Breadboard systems of five ultrasonic techniques were developed to inspect Saturn honeycomb composites: pulse echo interference, impedance, decrement, spectrum analysis, and intermodulation. Based on performance tests further development of the impedance system resulted in the successful detection and recording of disbonds in the honeycomb specimens. A number of semiautomated scanning and recording systems were developed to supplement the ultrasonic technique evaluation. An advanced, fully automated system was integrated with the ultrasonic detection system. The problem of bond strength determination was analyzed and the most promising approach and instrumentation were evaluated for feasibility. The DOT method which was proposed appears to be applicable to both the lap shear type application, and to honeycomb sandwich structures.

Author

**N67-15310#** Massachusetts Inst. of Tech., Cambridge. Surface Lab.
**SURFACE ENERGY EFFECTS IN SLIDING PHENOMENA Final Report, 1 Jul. 1963–30 Jun. 1966**
Ernest Rabinowicz 12 Sep. 1966 96 p refs
(Contract DA-31-124-ARO(D)-143)
(AROD-4266.4; AD-640180) CFSTI: HC $3.00/MF $0.75

It has been proposed that surface energy manifests itself in a sliding system through a characteristic distance, equal to the size of wear particles for that system. This hypothesis was tested in systems in which other distance parameters were introduced, namely abrasive particles of varying sizes, solid films of varying thickness, and sliding surfaces of varying roughness. A minimum load was postulated below which low wear rates would prevail, and a number of experiments were carried out to test this prediction. The effect of material compatibility on friction and wear were evaluated. The experimental results either agreed with the predictions of the surface energy model, or at any rate were not inconsistent with them.

Author (TAB)

**N67-15311#** Florida State Univ., Tallahassee. Dept. of Statistics.
**SURVEILLANCE PROBLEMS: TWO DIMENSIONAL WITH CONTINUOUS SURVEILLANCE**
Gordon Antelman, Bradley Russell, and I. Richard Savage Jul. 1966 41 p refs
(Contract Nonr-988(13))
(M113; AD-639655) CFSTI: HC $2.00/MF $0.50

The paper is concerned with optimal strategies for controlling a two-component Poisson production process under continuous surveillance. Either or both components may be repaired at any time at some cost. The long run average cost is used as the criterion for comparing strategies. The class of stationary Markovian strategies which do not permit hesitation and which allow production on only a finite number of states is shown to be a complete class of strategies under a certain assumption of monotonicity on the income function. Properties of optimal strategies are derived and the results applied to a numerical example.

Author (TAB)

**N67-15332#** Army Materials Research Agency, Watertown, Mass.
**VACUUM HEAT TREATING OF HIGH-STRENGTH STEEL CASTINGS**

Arthur Ayvazian Aug. 1966 22 p refs
(AMRA-TR-66-24; AD-640376) CFSTI: HC$1.00/MF$0.50

An investigation was conducted to verify the feasibility of employing vacuum heat treating as a means of improving the mechanical properties of high-strength steel castings. Eight octebar AISA 4340 and 4340 + 1.30 percent silicon steel castings, four vacuum induction melted and four air induction melted, were subjected to various combinations of vacuum and conventional heat treating. The results indicated no significant tangible evidence of any increase in mechanical properties when vacuum heat treated.
Author (TAB)

# 16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

**N67-14441*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**MICROWAVE MASER DEVELOPMENT: EXTENSION OF KYLSTRON TUNING RANGE**
R. Clauss *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 78-81 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF$1.50

The slow wave comb structures of two new tunable traveling wave masers were designed and loaded to give a tuning range which covers both 2295 and 2388 Mc. When the signal frequency is changed, the pump klystron frequency must also be changed. An external over coupled cavity is used with the pump klystron to extend its electronic tuning range. No mechanical adjustments at the maser package are necessary when the signal frequency is tuned to either 2295 or 2388 Mc. This frequency change may be accomplished entirely from the maser instrumentation rack.
R.N.A.

**N67-14893*#** Syracuse Univ. Research Corp., N. Y. Electronics Research Lab.
**STABILIZED GAS LASER OSCILLATORS Final Report, 24 Jun. 1964-21 Jun. 1966**
H. Muldoon, I. Bicevskis, and A. Steele 21 Jun. 1966 56 p
(Contract NAS5-3927)
(NASA-CR-80958) CFSTI: HC$3.00/MF$0.65 CSCL 20E

Design, development, fabrication, evaluation, and delivery of two phase-locked, frequency-stabilized gas lasers are discussed. The phase-locking scheme employed utilized the comparison of the frequency of a signal derived from a crystal oscillator to the frequency of the self-beat signal of the laser in order to generate an error signal which would minimize the difference frequency. It is concluded that these two laboratory prototypes have proven the feasibility and practicality of the phase-locking scheme employed.
Author

**N67-15070#** Sylvania Electric Products, Inc., Mountain View, Calif. Electronic Defense Labs.
**TECHNIQUES FOR SUPER-MODE OSCILLATION Interim Engineering Report, 1 Dec. 1965-28 Feb. 1966**
Russell Targ, B. J. McMurtry, J. M. Yarborough, and J. M. French 28 Feb. 1966 77 p refs
(Contract AF 33(615)-2884)
(IER-3; AD-633014) CFSTI: HC$3.00/MF$0.75

This report describes an experimental and theoretical program to determine the fundamental properties of the FM and super-mode lasers. These two techniques make it possible to obtain at a single frequency the full power of a high-power multimode laser without suffering the loss in power inherent in conventional approaches involving the suppression of modes. The work of this program is divided broadly between two main activities. The first is to obtain a more complete understanding of the physics governing the operation of the FM and super-mode lasers. The second is concerned with improving the techniques for coupling the modes of the FM laser and finding more efficient means for full power super-mode conversion of the FM signal to a monochromatic output.
TAB

**N67-15088#** Edgerton, Germeshausen and Grier, Inc., Bedford, Mass.
**DESIGN STUDY OF ADVANCED GEODETIC LASER SYSTEM Interim Scientific Report**
Sumner Ackerman 30 Sep. 1966 88 p refs
(Contract AF 19(628)-5518)
(AFCRL-66-731; SR-1; B-3417; AD-642153) CFSTI: HC $3.00/MF $0.65

The geodetic laser system described herein is to generate two intense beams of radiant energy so that a portion reflected from an assembly of retrodirective reflectors on a satellite can produce a detectable and identifiable point image on a photographic plate and an unambiguous photoelectric voltage pulse. The photographic image, taken against a calibrated stellar background, will be used to measure the angular position of the satellite, and the photoelectric signal to measure its slant range. These measurements will be made almost simultaneously and together establish the vector displacement between the ground-based laser system and the satellite at the time of observation. The distance to the satellite is generally more than 1000 km. The desired accuracies of the angular and range measurements are to less than 2 arc-seconds and to less than 10 meters respectively. Multiple observations will be made in each orbital pass to enhance identification of the photographic image and collect more data. The requirements and specifications for all major system components are established so that a reasonable compromise between desired performance and costs will be achieved. Design is carried out in detail only to the point of assurance that technological state-of-the-art exists which is consistent with the system requirements and the specifications.
Author (TAB)

**N67-15107#** Union Carbide Corp., East Chicago, Ind. Crystal Products Dept.
**PRODUCTION ENGINEERING MEASURE FOR RUBY LASER RODS Quarterly Progress Report, Jan. 1-Mar. 31, 1966**
M. K. Towne and R. L. Hutcheson 31 Mar. 1966 32 p refs
(Contract DA-36-039-AMC-06168(E))
(QPR-3; AD-642289) CFSTI: HC$3.00/MF$0.65

Single variable studies of standoff and gas flows have indicated definite optimum ranges. Boule diameter has an effect on boule quality but is not an independent variable. Furnace chamber diameter affects quality but growth is very difficult in the range where best quality was achieved. Initial multi-variable studies indicated an advantage for pulsed powder feed but other factors should be checked before drawing a definite conclusion.
Author (TAB)

**N67-15312#** Sylvania Electric Products, Inc., Mountain View, Calif. Electronic Defense Labs.
**TECHNIQUES FOR SUPER-MODE OSCILLATION Interim Engineering Report, 1 Jul.-30 Sep. 1966**
Russell Targ and J. M. French 30 Sep. 1966 36 p refs
(Contract AF 33(615)-2884)
(IER-5; AD-640143) CFSTI: HC$2.00/MF$0.50

Construction of an automatic frequency control system for the absolute frequency stabilization of our 2-meter long, 50 mw FM laser was completed. The FM laser produces an error signal which increases as the laser frequency drifts with respect to the center of the Doppler-broadened fluorescence line. The electrical phase of the error signal changes by 180 degrees as the laser drifts from one side of line center to the other. The servo-system generates a control signal of the appropriate magnitude and sign to move a laser mirror attached to a piezoelectric crystal, and cancels any tendency of the laser frequency to drift from line center.

The discontinuous 180-degree change of phase in the error signal at line center was measured. The profile of the extremely sharp discriminant was measured and shown to agree satisfactorily with that predicted by theory. The FM laser controlled by this servo-system was demodulated by means of optical heterodyne detection by photomixing with a laser of known stability. This photomixing experiment showed that the FM laser is, at present, absolutely stabilized to within 1.5 MHz of line center. Work is now under way to improve this preliminary figure. TAB

N67-15327# Hughes Research Labs., Malibu, Calif.
**SELECTIVE ACCESS LASER DISPLAY BEAM POSITIONER Quarterly Report, 1 Mar.–31 May 1966**
J. F. Lotspeich, W. P. Brown, Jr., R. G. Dixon, J. E. Kiefer, R. G. Phelps, Jr. et al Griffiss AFB, N. Y., RADC, Aug. 1966 64 p refs
(Contract AF 30(602)-4097)
(RADC-TR-66-447; QR-1; AD-639968) CFSTI: HC $3.00/MF $0.75

The objective of the contract is to investigate, theoretically and experimentally, techniques for achieving a high-speed, two-dimensional deflection of a cw visible laser beam. Specifically, this effort is directed toward meeting the requirements of a selective access laser display beam positioner which is capable of presenting a flexible format and multi-color image for a large screen tactical display in Air Force command and control centers. Author (TAB)

# 17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N67-14503*# Princeton Univ., N. J.
**EXPERIMENTAL DATA ON ALUMINUM AS AN UNSTABLE SOLID**
O. W. Dillon, Jr. *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 377–394 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00
(Grant AF-AFOSR-406-63)

Experimental results are presented on incrementally loaded specimens of annealed aluminum. Time intervals of 30 min. between loads are used. It is found that sudden and large changes in strain occur at constant, but discrete, values of the load. The response between unstable loads is approximately elastic. The changes in strain are delayed with respect to the time of load application. They propagate as slow waves whose speed is usually $10^{-4}$ times the value obtained by using smoothed load-deflection data (in constructing the constitutive equation for the material). Slower waves than this are also described. These slow waves raise the question of whether or not standard tests are made at equilibrium conditions. Considering the material as being mechanically unstable, the data appear to be consistent in the sense that the tangent modulus is not always positive. Author

N67-14615# Iowa State Univ. of Science and Technology, Ames. Ames Lab.
**RESEARCH REPORT IN METALLURGY**
F. H. Spedding, H. A. Wilhelm, O. N. Carlson, C. W. Chen, P. Chiotti et al *In its* Chem., Eng., Met., Phys. and Reactor Div. Jul. 1966 95 p ref (See N67-14612 05-34) CFSTI: HC $7.94/MF $2.25

High temperature materials development is reported in metal preparation and purification, phase relationships and thermodynamic properties, mechanical behavior and forming of reactor materials, and separation studies. In addition, the properties, processes, and structure of these materials is discussed. S.P.

N67-14677# Illinois Univ., Urbana. Dept. of Theoretical and Applied Mechanics.
**MECHANISMS OF ENVIRONMENT INDUCED SUBCRITICAL FLAW GROWTH IN AISI 4340 STEEL Interim Technical Report**
William Alan Van der Sluys Sep. 1966 47 p refs
(Contract DA-31-124-ARO(D)-378)
(TEAM-292; AROD-5612-1; AD-639668) CFSTI: HC $2.00/MF $0.50

Results of an experiment designed to study the effect of several variables on subcritical crack growth rate of a high-strength steel in a water environment are presented. Environmental variables included temperature, pH of the liquid environment, electric charging, and the combined effect of pH and electric charging. Tapered double cantilever beam specimens were designed so that the level was maintained constant at a constant load and independent of crack length. Thus steady-state crack growth measurements were possible in constant load and constant environment experiments. With this specimen design, it was possible to make a series of measurements that covered the entire range of effects of a particular variable using only one specimen. Author (TAB)

N67-14684# MSA Research Corp., Evans City, Pa.
**EFFECT OF HIGH TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. MECHANICAL PROPERTIES OF MATERIALS Quarterly Progress Report, Apr.–Jun. 1966**
R. C. Andrews and K. R. Barker Jul. 1966 66 p refs
(Contract AT(11-1)-765)
(MSAR-66-149) CFSTI: HC $3.00/MF $0.75

The mechanical strengths of candidate structural materials in various environments were studied. A test of 304 ss in 1200°F high-$O_2$ (300 ppm) Na was conducted. Unstressed specimens were also exposed to the high-$O_2$ Na environment and a He environment for subsequent mechanical testing. The testing of these exposed materials is in progress. A test of 304 ss in 1200°F high-C Na also was conducted. The fatigue tests are continuing, and the testing of exposed specimens was initiated. The base-line air data (creep, creep-rupture and tensile) tests for this heat of 304 ss are in progress. Fatigue tests are in progress in a He environment. The preliminary results of completed tests to date are presented. Metallographic studies were used to trace anomalies in fatigue data of high-$O_2$ Na environment to differences in C absorption. All other metallographic monitoring of specimens and tabs in either environment reveals no deviations of trends noted in testing. The testing of the initial out-of-house Linear Variable Differential Transformer (LVDT) units resulted in satisfactory performance of the units and associated auxiliary equipment up to ≈800°F. However, at a temperature of 1200°F, the performance is erratic. Modification and testing are continuing. Analytical studies are in progress on cold traps operated in environments of high-C and high-$O_2$ (300 ppm) Na. The cold traps were sampled by coring. Preliminary data are included on the concentrations found regarding $O_2$, $H_2$, C (both in the Na and in the mesh), $N_2$, and metal elements. NSA

N67-14711# Rock Island Arsenal Lab., Ill. Research and Engineering Div.
**HYDROGEN EMBRITTLEMENT OF STEEL IN METAL FINISHING PROCESSES OF BLACK OXIDE AND ZINC PHOSPHATIZE**

Russell H. Wolff Jun. 1966 27 p refs
(RIA-66-2008; AD-640176) CFSTI: HC $2.00/MF $0.50

Static load tests were conducted with notched, steel tensile specimens after processing in black oxide (specification MIL-C-13924 Class 1) and also after processing in zinc phosphatize solution (specification MIL-P-16232C Type Z), to determine embrittlement characteristics of these processes. The scope of work was limited to a brief survey to determine whether the problem was serious for these processes. Results based on the use of types 4140, 1045 and 1095 steel specimens at hardness of Rockwell C 50 show that embrittlement is not a problem with the black oxide process. The zinc phosphatize process is critically embrittling, and relief treatment for higher strength steels is advisable. Author (TAB)

N67-14755# Naval Civil Engineering Lab., Port Hueneme, Calif.
**DYNAMIC TESTS OF STRUCTURAL ALUMINUM ALLOYS Technical Report, Dec. 1964–Mar. 1966**
W. L. Cowell Sep. 1966 28 p refs
(R-478; AD-640369) CFSTI: HC $2.00/MF $0.50

A series of dynamic tests was conducted on three grades of structural aluminum alloys: (a) 6061-T6, (b) 6063-T5, and (c) 5456-H321. The effects of strain rate on the mechanical properties of these materials were obtained. In the elastic range of the material tested, the strain rate ranged from a static value of 0.000022 in./in./sec to a maximum value of 2.5 in./in./sec. The mechanical properties of the alloys showed a variety of changes when subjected to high strain rates. The 6061-T6 aluminum increased 5% and 10.6% over the static value for yield stress and tensile strength, respectively, at the maximum test rates. The 6063-T5 aluminum showed no change in yield stress and a 5.8% increase in tensile strength at the maximum test rate. The 5456-H321 aluminum was obtained in plate form, and specimens were prepared with their longitudinal axes both parallel and perpendicular to the direction of rolling. The yield stress for specimens prepared parallel to the direction of rolling decreased 3.6%, and the yield stress for specimens prepared perpendicular to the direction of rolling increased 2.5% at the maximum test rate. The direction of rolling did not affect the tensile strength behavior under rapid testing since both groups of 5456-H321 alloy exhibited an average reduction of 5.7% in tensile strength at the maximum test rate. None of the changes in mechanical properties are believed to be of sufficient magnitude to be of concern in design. Author (TAB)

N67-14801# Argentina. Comision Nacional de Energia Atomica, Buenos Aires. Departamento de Metalurgia.
**FIRST LATIN AMERICAN CONFERENCE ON PROCESS METALLURGY AND METAL WORKING, VOLUME I [PRIMERA CONFERENCIA DE EXPERTOS LATINOAMERICANOS EN METALURGIA DE TRANSFORMACION, VOLUMEN I]**
Aug. 1966 436 p refs In SPANISH, ENGLISH, and PORTUGUESE Conf. held in Buenos Aires, 18–23 Aug. 1964
(Grant AF-AFOSR-717-65)
(AFOSR-66-2001, Vol. I; AD-640370) CFSTI: HC $7.30/MF $2.00

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13. COLD COMPACTION OF ALUMINUM AND ALUMINUM BASE ALLOYS J. R. Merhar and F. J. Semal (Army Mater. Res. Agency) 23 p refs (See N67-14814 05-17)

14. HARDENABILITY OF CONSTRUCTIONAL STEEL D. Farias (Cordoba Natl. Univ.) 27 p refs (See N67-14815 05-17)

15. HIGH-SILICON IRON CASTINGS, OF HIGH CORROSION RESISTANCE, FOR CHEMICAL PLANTS G. Guimaraes and N. Sugiyama (Inst. de Persquisas Technol.) 46 p refs (See N67-14816 05-17)

N67-14808 Carnegie Inst. of Tech., Pittsburgh, Pa.
**SOME REMARKS ON THE PHYSICAL METALLURGY OF IRON AND STEEL**
H. W. Paxton *In* Arg. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 60 p refs Sponsored by ONR and NSF (See N67-14801 05-17) CFSTI: HC $7.30/MF $2.00

First, a review of the thermodynamics of iron-base systems is presented since, although most structures with desirable properties are very markedly not in equilibrium, the equilibrium situations involved must be known in order to have confidence in the previous knowledge. To the extent possible, an atomistic approach has been utilized. This review is followed by a study of the nucleation and diffusion controlled growth kinetics of phases in steels involving austenite formation and transformation. Next the three major phases in steels, austenite, ferrite and martensite are analyzed and illustrative examples of various properties are given. The aggregate phases such as pearlite and bainite, and the products of eutectoid decomposition have been neglected not because their importance is slight, but to maintain the paper to a reasonable length. Finally some suggestions are made as to interesting areas of research which may also be profitable. Author

N67-14809 Battelle Memorial Inst., Columbus, Ohio.
**NEW AMERICAN ULTRAHIGH-STRENGTH STEELS**
F. R. Morral *In* Arg. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 24 p refs (See N67-14801 05-17) CFSTI: HC $7.30/MF $2.00

There are several reasons (design, metallurgical, and economic) for the development of ultra-high-strength steels. In the design of parts for airplane and rockets, high-strength–density ratios are needed; on earth, low cost steels by weight reduction; and under water, submarine steels to resist higher pressures at higher depths. The limit of strength is the binding force between iron atoms: 2,800 $Kg/mm^2$. Research so far has included balancing the chemical composition, which will require suitable heat treatment (maraging), using suitable work-heat treatment sequences (ausforming), and possible combinations of the above. The properties of steel of the first two types are given. Author

**N67-14811** Frankford Arsenal, Philadelphia, Pa.
**CELLULAR METALLIC MATERIALS**
S. Lipson *In* Arg. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 43 p refs (See N67-14801 05-17) CFSTI: HC $7.30/MF $2.00

A process for the production of cellular metals is described. The process consists of preparing a refractory mold, filling the mold with soluble granules which correspond to the size and shape of the pores desired in the metal, and infiltrating the metal into this soluble aggregate. After leaching with a suitable solvent, the metal has a void structure of interconnecting cells which correspond to the shape and size of the soluble aggregate. The apparent density of the metal body can be controlled from a maximum of approximately one-third of its base density to some lower density in the order of one-fifth the base density. Data are presented on mechanical and physical properties of the materials. The possibility for altering the cell geometry by extrusion of cast cellular billets is demonstrated. Potential applications for material of this type are reviewed. Author

**N67-14812** Catholic Univ., Santiago (Chile).
**STEEL WELDABILITY CRITERIA [CRITERIO DE SOLDABILIDAD DE ACERO]**
Julio Fava, Elias Ayarza, and Alvaro Covarrubias *In* Arg. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. 1 Aug. 1966 23 p refs In SPANISH; ENGLISH summary (See N67-14801 05-17) CFSTI: HC $7.30/MF $2.00

The weldability of a steel derives from its ability to withstand the welding thermal cycle, without appreciable loss in mechanical properties. The common defects introduced by welding are classified in four groups: cracks under the seam, brittleness of the heat-affected zone, cracking of the seam and porosity. The different known tests to evaluate steel weldments as affected by those defects are analyzed next. Finally, the results of the experiments made with pressure vessel steel type A-212, grade B, are presented. Author

**N67-14814** Army Materials Research Agency, Watertown, Mass.
**COLD COMPACTION OF ALUMINUM AND ALUMINUM BASE ALLOYS**
J. R. Merhar and F. J. Semel *In* Arg. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 23 p refs (See N67-14801 05-17) CFSTI: HC $7.30/MF $2.00

The objective of the research described was to develop techniques to improve the mechanical properties, especially ductility, of aluminum and aluminum base prealloyed powder compacts, fabricated by conventional cold compaction and sintering operations which can be made applicable to a production process. The satisfactory results of experiments made with 1100 aluminum powders are presented. For aluminum base alloys the compaction characteristics of 1100 powders are reproduced when a mixture of elemental powders is used instead of prealloyed powders. Author

**N67-14815** Cordoba National Univ. (Argentina).
**HARDENABILITY OF CONSTRUCTIONAL STEEL [TEMPLABILIDAD DE ACEROS DE CONSTRUCCION]**
Dionisio Fairas *In* Arg. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 27 p refs In SPANISH; ENGLISH summary (See N67-14801 05-17) CFSTI: HC $7.30/MF $2.00

A series of experiments performed with the purpose of determining the hardenability parameters of alloy steels most commonly used in Argentina are summarized. An attempt is made to lay down the technical and scientific bases of hardenability and critical diameter determinations and interpretations, in order to help the users in the selection of the most adequate steels, and in their handling during the different technological processes. Jominy curves were determined for specimens quenched and tempered at different temperatures. The results were compared with those obtained using the steel calculator by Calvo Rodes. Author

**N67-14816** Instituto de Pesquisas Tecnologicas, Sao Paulo (Brazil).
**HIGH-SILICO IRON CASTINGS, OF HIGH CORROSION RESISTANCE, FOR CHEMICAL PLANTS [FUNDICAO DE PECAS DE FERRO FUNDIDO DE ALTO SILICIO, COM ELEVADA RESISTENCIA A CORROSAO, PARA INDUSTRIAS QUIMICAS]**
Cyro Guimaraes and Noriyuki Sugiyama *In* Arg. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 46 p refs In PORTUGUESE; ENGLISH summary (See N67-14801 05-17) CFSTI: HC $7.30/MF $2.00

Chemical composition, mechanical and physical properties and corrosion resistance characteristics of high-silicon cast iron are summarized. The experiments carried out at the IPT are described. Studies were concentrated on developing sound casting techniques, degassing of the metal, and heat treatment of the castings to minimize the effects of residual stresses. Author

**N67-14924*#** Vitro Labs., West Orange, N. J.
**DEVELOPMENT OF PROTECTIVE COATINGS FOR TANTALUM T-22 ALLOY Final Summary Report**
M. H. Ortner and S. J. Klach Dec. 1966 123 p refs
(Contract NAS3-7613)
(NASA-CR-54578) CFSTI: HC $3.00/MF $1.30 CSCL 11F

A variety of single phase and binary intermetallic compounds were electrophoretically deposited upon tantalum T-222 alloy both with and without intervening barrier layers of tungsten and rhenium. These coatings were tested for long term, one atmosphere cyclic oxidation resistance at 1500° and 2400°F. Promising systems were examined in more detail by metallography and by electron microprobe analysis. Of the systems studied to date, $MoSi_2$–30$VSi_2$ has yielded the best results. Two of eight samples of this coating which were tested survived 600 hours exposure at both 1500° and 2400°F, including approximately 30 cycles to room temperature without failure. Other binary silicide systems containing either $WSi_2$ or $MoSi_2$ combined with 3–30%$CrSi_2$ or $TiSi_2$ have performed well at 2400°F, but are subject to pest failure at the lower test temperature. Author

**N67-14958#** Naval Research Lab., Washington, D. C.
**AN ANNOTATED BIBLIOGRAPHY OF RECENT PAPERS AND REPORTS ON THE SUBJECT OF AMBIENT TEMPERATURE AQUEOUS STRESS-CORROSION CRACKING OF TITANIUM AND TITANIUM ALLOYS**
E. P. Dahlberg Oct. 1966 8 p refs
(ARPA Order 878)
(NRL-BIBL-29; AD-642128) CFSTI: HC $3.00/MF $0.65

A listing is presented of sixteen recent papers and reports which deal with stress-corrosion cracking studies of titanium and titanium alloys. The complication is limited to cracking phenomena in aqueous solutions at or near room temperature. A brief summary of the important aspects of each report is included. Author (TAB)

**N67-15028#** Rock Island Arsenal Lab., Ill. Research and Engineering Div.

**THE EFFECT OF HYDROGEN IN END-CHILLED CAST PLATES OF A356 ALUMINUM ALLOY**

Richard B. Miclot Aug. 1966 18 p

(RIA-66-2516; AD-639950) CFSTI: HC $1.00/MF $0.50

The report summarizes the results of tests for hydrogen content, mechanical properties, and solidification rates in end-chilled cast plates of A356 aluminum alloy. Drastically chilled regions of castings exhibit lower hydrogen content than under-riser sections. Lower tensile strength and elongation in castings are obtained with higher hydrogen content in either chilled or slowly solidified parts. Yield strength is not severely impaired in directionally fed sections of cast plates from gassed melts even at remote distances from a chill. Author (TAB)

**N67-15260*#** Solar, San Diego, Calif.

**STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS**

Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs

(Contract NAS7-469)

(NASA-CR-81140; RDR-1534-2) CFSTI: HC $3.00/MF $0.65

CSCL 11F

The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43. Author

**N67-15295#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**RADIATION CAPACITY OF SOME INDUSTRIAL ALLOYS IN THE INFRARED RANGE OF THE SPECTRUM**

V. V. Lebedeva and V. K. Novik 13 Apr. 1966 11 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk: Met. i Gornoye Delo (Moscow), no. 4, 1964 p 143–146

(FTD-TT-65-1796; TT-66-62445; AD-640310) CFSTI: HC $1.00/MF $0.50

An investigation was made of the radiation capacity of the aluminum alloys AD1 and D16 at the temperature of 100 - 400 C, and also of brass L62 and the steels St. 3 and St. 45 at temperatures of 100 - 650 C in the infrared region of the spectrum with the long waves of the length wavelength = 2 - 14 microns. The results of the investigations and the values obtained for the monochromatic radiation capacity of a number of alloys under various conditions enables the selection of receivers of radiation in accordance with their spectra and power properties, as well as providing the possibility of computing the designs and elements of the optical tract of the checking and measuring instruments. TAB

**N67-15308#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**STUDYING CYCLIC STRENGTH OF METALS BY THE METHOD OF RECORDING FATIGUE DIAGRAMS**

T. A. Lebedev, T. K. Marinets, and A. I. Yefremov 29 Apr. 1966 14 p refs Transl. into ENGLISH from Tr. Inst. Met. Akad. Nauk SSSR (Moscow), 1962 p 141–146

(FTD-TT-65-1402; TT-66-62429; AD-640287) CFSTI: HC $1.00/MF $0.50

Conclusions: By recording the fatigue diagram of samples tested under the effect of cyclic loads, an indirect representation can be obtained of when fatigue of metals appears and the formation of fatigue fracture does take place. It therefore appears advisable to carry out an investigation of fatigue strength of metals by the proposed method on a much wider circle of materials. TAB

**N67-15315#** Boeing Scientific Research Labs., Seattle, Wash. Solid State Physics Lab.

**STRESS CORROSION CRACKING OF TITANIUM ALLOYS. PRELIMINARY REPORT ON Ti:8Al–1Mo–1V ALLOY AND PROPOSED ELECTROCHEMICAL MECHANISM**

T. R. Beck Jul. 1966 111 p refs

(D1-82-0554; AD-640229) CFSTI: HC $4.00/MF $0.75

Stress corrosion cracking of titanium: 8% Al - 1% Mo - 1% V alloy specimens was investigated in various salt solutions at controlled potentials applied by a potentiostat. Polarization curves on titanium oxide surfaces and kinetic data for oxidation of newly formed titanium alloy surface were also obtained. It was found that stress corrosion cracking of duplex annealed Ti:8-1-1 alloy occurred in chloride, bromide, and iodide solutions but did not occur in other solutions such as fluoride, hydroxide, sulfide, sulfate, nitrate or perchlorate. The ultimate strength was strongly dependent upon potential. The velocity of crack propagation and current flowing into the crack in chloride, bromide and iodide solutions were linearly related to the applied potential above a potential of -900 mv to the saturated colomel electrode. An electrochemical model was developed to interpret the data. Anodic reaction with the halides is considered to initiate at the -900 mv potential and the rate of crack propagation to be limited by the potential drop through the electrolyte in the crack. It is planned to extend the investigation to other alloys using the model as a guide for the design of experiments. Author (TAB)

**N67-15340#** Allied Research Associates, Inc., Concord, Mass.

**TIME-DEPENDENT COMPRESSION PROPERTIES OF ALUMINUM ALLOY 2024-0 AT 500 F (533 K)**

Ralph Papirno 31 Oct. 1966 49 p refs

(Contract DA-31-124-ARO(D)-337)

(ARA-290-4; AROD-5469-1; AD-642159) CFSTI: HC $3.00/MF $0.65

Compression creep and compression constant strain-rate tests were performed on thick wall cylindrical specimens of aluminum alloy 2024-0 at 500°F (533°K). Using the assumption that the equation of state of the material is a function only of stress, strain, and strain rate, the creep curves were analyzed to yield constant strain-rate, stress strain data. Comparisons between the creep-derived and the directly measured constant strain-rate data show that the data are not exactly equivalent but the discrepancies are sufficiently small so that to a first approximation the equation of state assumption can be considered valid. The data presented will be utilized in the next state of the investigation, to develop theoretical results for the Gerard theory of time dependent plastic stability for comparison with experiments now in progress. Author (TAB)

# 18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

**N67-14463*#** Sheffield Univ. (England). Dept. of Glass Technology.

**RHEOLOGY OF INORGANIC GLASSES**

R. W. Douglas *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 3–27 refs (See N67-14462 05-34) CFSTI: HC$7.00/MF$1.75

When the viscosity of glass-forming liquids falls below about $10^{12}$ poises, the behavior is Newtonian. It is probable that in complex glasses there is a change of the mechanism of flow at very high temperatures. At temperatures corresponding to viscosities between about $10^{12}$ and $10^{17}$ poises, which is conveniently called the Transformation Range, the properties of glasses change slowly with time until the atomic configuration comes into equilibrium at the temperature of the experiment. Glasses in this condition still show delayed elasticity which may be described to an approximation nearly within possible experimental error by a relaxation function, $\exp[-(t/\tau)^{\alpha}]$. The change of $\tau$ with temperature leads to an apparent activation energy in typical soda–lime–silica glasses of about 150 kcal./mole which is equal to that of the shear viscosity and a bulk viscosity estimated from volume relaxation in a transformation range. These observations imply that it would be impossible to measure a steady state viscosity in such glasses above about $10^{20}$ poises. Author

**N67-14464*#** Kyoto Univ. (Japan).

**THE DEFORMATION PROCESS AND STRUCTURE OF CRYSTALLINE POLYMERS**

Masao Horio *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 29–55 refs (See N67-14462 05-34) CFSTI: HC$7.00/MF$1.75

The relationship between deformation and the changing structure of crystalline polymers is studied through X-ray diffraction patterns of nylon 6 and polyethylene films stretched in both the casting and transverse directions. The patterns are associated with specific molecular folding configurations. Measurements of the lattice strain and infrared spectra are also utilized. Author

**N67-14469*#** Research Triangle Inst., Durham, N. C. Camille Dreyfus Lab.

**NON-NEWTONIAN INTRINSIC VISCOSITY OF POLYMER SOLUTIONS**

A. Peterlin *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 123–141 refs (See N67-14462 05-34) CFSTI: HC$7.00/MF$1.75

The theory of the gradient dependence of intrinsic viscosity of unbranched linear macromolecules of sufficiently high molecular weight predicts an initial drop of $[\eta]$ proportional with the square of the gradient. After a while, a minimum is reached with a slower subsequent increase. The viscosity increases to a maximum and then drops monotonously to $[\eta]_{\infty}$. With smaller molecular weight the maximum and minimum merge and finally completely disappear. This behavior, which is a consequence of a reduction of hydrodynamic interaction with increasing deformation of the coiled macromolecule in laminar flow, may be completely obscured if the resistance of the macromolecule against rapid shape changes is sufficiently high. In that case the coil expands so much less that the change in hydrodynamic interaction leading to the above-mentioned minimum and maximum is completely compensated by the orientational effects which continuously depress the intrinsic viscosity. In usual solvents with a viscosity about 1 cp. the coil rigidity strongly prevails over the deformation forces exerted by the solvent. Extremely high viscosity of the solvent (between 10 and 100 poises) reverses the situation so that deformational effects prevail and solutions of sufficiently high molecular weight linear polymers exhibit the upturn in intrinsic viscosity in good agreement with theoretical predictions. Author

**N67-14471*#** Kyushu Univ., Fukuoka (Japan). Dept. of Applied Chemistry.

**VISCOELASTIC BEHAVIOR OF CRYSTALLINE POLYMERS**

Motowo Takayanagi *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 161–187 refs (See N67-14462 05-34) CFSTI: HC$7.00/MF$1.75

The complex modulus of the mat of the single crystals of polyethylene is measured as a function of temperature and frequency. The relaxation spectrum concerned with crystalline dispersion is obtained from the above results. Crystalline dispersion of the bulk-crystallized sample is composed of two dispersions: one is dispersion with a higher activation energy, which is scarcely found in the single crystal sample, and the other is common to both samples. Stress relaxation of polyethylene terephthalate around the primary dispersion region is measured. The loss modulus calculated from the relaxation spectrum is in accordance with the directly measured dynamic value. The shape of the spectrum becomes broader with increasing crystallinity. The results of solvent extraction of the bulk-crystallized poly-α-olefin leads one to believe that the noncrystalline region forms a phase separate from the crystal lattice. The simple equivalent model of the crystalline polymer is constructed from two materials. These model specimens represent the features of the viscoelastic behavior of crystalline polymers. Author

**N67-14484*#** California Inst. of Tech., Pasadena.

**APPLICATION OF FINITE ANISOTROPIC ELASTICITY TO THE BEHAVIOR OF NATURAL RUBBERS**

W. L. Ko and P. J. Blatz *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 35–50 refs (See N67-14581 05-34) CFSTI: HC$10.34/MF$3.00

(Contract P.O.S.-420061-OP)

Experimental data have been procured which describe the behavior of natural rubber (2% sulfur) in uniaxial and biaxial stress fields. These data are analyzed in terms of an anisotropic strain energy function. It is found that this function fits the overall data excellently for the entire region of extensions. It is also established that the term which measures the anisotropy contributes significantly to the strain energy function only in the region of large extensions. Thus such a function may be used as a realistic approximation for a material which remains isotropic up to some critical extension beyond which material anisotropy sets in. For clarification purposes, the distinction between true material anisotropy and so-called stress-induced anisotropy is exemplified. Author

**N67-14502*#** Esso Research and Engineering Co., Linden, N. J. Products Research Div.

**STUDIES OF FLOW BIREFRINGENCE OF POLYSTYRENE SOLUTIONS**

W. Philippoff *In* Brown Univ. Proc. of the 4th Congr. on Rheol., Pt. 2 1966 p 343–373 refs (See N67-14581 05-34) CFSTI: HC$10.34/MF$3.00

Flow birefringence measurements were made on a monodisperse polystyrene S111, and on a polydisperse one, PF-139, in the viscous solvent Aroclor 1248 in a wide range of concentrations and rates of shear. The calculation of the values pertinent to the polymer was performed by several mathematical

procedures. The results show that there is no significant qualitative difference in the behavior of high polymers dissolved in low viscosity solvents (bromoform) and high viscosity solvents such as Aroclor. The so-called Frisman effect was substantiated for a high molecular weight polystyrene in dioxane. The non-Newtonian viscosity of the solutions in Aroclor was extremely similar to the one measured by Schultz and Hermann in toluene at about the same concentration. The values compared practically quantitatively with those of other investigators on polystyrene. Author

N67-14507*# California Research Corp., Richmond.
**THE ENTANGLEMENT CHAIN LENGTH AND POLYMER COMPOSITION**
Roger S. Porter and Julian F. Johnson *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 467–477 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

The entanglement point is a documented phenomenon for linear amorphous polymers. This transition point, at a critical chain length, has been observed for polymers of a dozen types. The molecular weight and chain length at the entanglement point are interpreted in terms of polymer chain composition, and the composition and volume of groups appended to the chain. The entanglement chain length for vinyl polymers has been equated to the molar volume of short, nonpolar pendant groups. This regular increase of entanglement spacing with the size of pendant groups is likely due to decreased chain flexibility caused by steric hindrance of pendant groups. For many vinyl polymers, entanglement chain length also increases generally with glass transition temperature and with activation energy for viscous flow. The possible relationship of entanglement spacing to other properties, such as heats of polymerization and polymer dimensions at theta conditions, are also considered. Conclusions are corroborated by new entanglement chain lengths derived from non-Newtonian flow for several additional polymers. The variation of entanglement point with polymer concentration, solvent, and temperature is also evaluated from available data. Author

N67-14508*# California Research Corp., Richmond.
**THE ENTANGLEMENT REGION AND NON-NEWTONIAN POLYMER FLOW**
Roger S. Porter, Manfred J. R. Cantow, and Julian F. Johnson *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 479–489 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

The shear dependence of viscosity for concentrated polymer systems has been related to polymer molecular weight distribution. Polyisobutenes were studied for which distributions have been developed from fractionation and refractionation. Measurements were made principally with a high-shear, rotational, concentric cylinder viscometer. Two types of reduced variables are evaluated for interpreting non-Newtonian flow. Using either a reduced shear rate or a reduced stress, non-Newtonian data can be satisfactorily superimposed at a series of concentrations and temperatures for amorphous polymers of similar molecular weight distribution. The narrower the molecular weight distribution, the narrower the shear range for non-Newtonian flow. In consequence, monodisperse polymers exhibit non-Newtonian flow at over a decade higher in shear rate and stress than polymers with most probable distribution. It was found that several vinyl polymers of narrow molecular weight distributions also fit a reduced variable curve for non-Newtonian flow but of significantly different shear dependence than data on broad distributions of these polymers. Author

N67-14509*# Wisconsin Univ., Madison. Dept. of Chemistry.
**VISCOELASTIC PROPERTIES OF POLYVINYL ACETATES. III: MECHANICAL LOSS AND MOLECULAR WEIGHT DISTRIBUTION**
Yasuji Oyanagi and John D. Ferry *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 491–503 refs Sponsored in part by NSF (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

The mechanical loss tangent (tan $\delta$) has been measured for 4 fractions of polyvinyl acetate and 24 binary blends of fractions, at frequencies between 0.08 and 5 cps and various temperatures, in the region where tan $\delta$ passes through a minimum. For each fraction and blend, the temperature dependence was described by the method of reduced variables. For the fractions and blends in which both molecular weights exceeded the critical value for entanglement coupling ($M_c$), the magnitude of tan $\delta$ at its minimum was expressed by a linear relation. For the blends in which only one molecular weight exceeded $M_c$, tan $\delta_m$ was smaller than would be predicted by this relation and it could not be expressed by any simple empirical equation. In blends of two components with molecular weights exceeding $M_c$, the frequency location of the minimum shifted down with increasing proportion of the component of higher molecular weight. In blends with one component of molecular weight less than $M_c$, the location of the minimum was nearly independent of composition. Author

N67-14510*# American Cyanamid Co., Stamford, Conn. Chemical Research Dept.
**A PHENOMENOLOGICAL INTERPRETATION OF THE DYNAMIC GLASS TRANSITION**
Armand F. Lewis and O. Griffin Lewis *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 p 505–523 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

An interpretation of the glass transition is presented in terms of the viscoelastic state variables—temperature, frequency, and composition. The approach is based on the use of the dynamic mechanical loss peak as an index of the glass transition. Using this definition, three dimensional plots may be constructed to display the temperature–frequency composition effects on the glass transition of polymeric systems. The surface represented in this diagram, called the glass transition barrier, is discussed from experimental and theoretical viewpoints. The temperature–composition contour of the glass transition barrier has been treated in terms of a simplified free volume theory, while the frequency dependence of the glass transition temperature has been analyzed in terms of the Arrhenius equation. The temperature–frequency treatment has yielded a number of empirical relations—one which classified polymers into two distinct types depending on their frequency–temperature behavior and another equation which relates the dynamic glass transition at a hypothetical frequency of $10^{-1.5}$ to the (dilatometric) glass temperature. Author

N67-14511*# Stanford Research Inst., Menlo Park, Calif.
**ULTIMATE TENSILE PROPERTIES OF ELASTOMERS. III: DEPENDENCE OF THE FAILURE ENVELOPE ON CROSSLINK DENSITY**
Thor L. Smith *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 525–541 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00
(Contract AF 33(657)-8186)

The ultimate tensile properties of amorphous unfilled elastomers can be characterized by a failure envelope. To determine the effect of crosslink density on the failure envelope, a study was made of eight vulcanizates of a hydrofluorocarbon elastomer. The number of effective network chains, $\nu_e$, in these vulcanizates varied from $0.38\times10^{-4}$ to $9.46\times10^{-4}$ mole/cm$^3$. Ultimate tensile properties were determined at temperatures between −5° and 320°C and at seven to ten extension rates at each temperature. The data gave a master failure envelope. This behavior shows that the maximum value of $(\lambda_b - 1)$ is inversely proportional to $\nu_e$, where $\lambda_b$ is the ultimate extension ratio. Ultimate tensile properties of one

vulcanizate were also determined under constant loads at four temperatures and the data were found to yield the same envelope as those from tests made at constant rates of extension. Author

N67-14512*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**THE TENSILE FAILURE ENVELOPE OF AMORPHOUS ELASTOMERS: EFFECTS OF STATISTICAL VARIABILITY AND CROSSLINK DENSITY**
Robert F. Landel and Robert F. Fedors *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 543–566 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00
(Contract NAS7-100)

The statistical variability of both rupture stress, $\sigma_b$, and rupture strain, $\epsilon_b$, was studied by breaking ring specimens of peroxide cured styrene butadiene rubber at a strain rate of 2.32 per min at 23°, −10°, and 40°C. The statistical distribution for both $\sigma_b$ and $\epsilon_b$ can be described by a double exponential cumulative distribution function. The rupture points plotted as a Smith failure envelope define the same envelope as that determined by breaking single specimens at varying rates and temperatures. It is demonstrated that the high temperature portions of the failure envelopes of some systems could be superposed to a single master curve. The form of the master curve can be described by the Martin–Roth–Stiehler expression for the stress–strain curve of an elastomer. It is also pointed out that for systems that follow the master curve, the concentration of effective network chains can be determined by breaking multiple specimens at an appropriate rate and temperature and comparing the resulting portion of the failure envelope with the master curve. Author

N67-14515*# Delaware Univ., Newark.
**MEASUREMENT OF NORMAL STRESSES IN VISCOELASTIC MATERIALS AT HIGH SHEAR RATES**
C. R. Shertzer and A. B. Metzner *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 603–618 refs Sponsored by part by NSF (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

A technique is described for obtaining the two normal stress differences (as well as the shearing stress) of viscoelastic fluids under steady laminar flow conditions and at the high rates of deformation of primary interest industrially. Equations are developed for calculating the normal stress differences from measurements of the axial and radial components of the thrust exerted by a fluid jet. Experimental determinations of one of the normal stress differences are reported for two polymeric solutions to illustrate the use of this technique and to verify the assumptions introduced in the analysis. Author

N67-14517*# Pittsburgh Plate Glass Co., Pa. Glass Research Center.
**PHENOMENOLOGICAL VISCOELASTICITY OF GLASS**
Fenton L. Bagley, Jr. and Tse-chien Woo *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 643–657 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

Creep data for temperatures of 450°, 500°, 550°, 600°, and 625°C of soda-lime plate glass are presented. The dependence of viscoelastic properties on preheat, load variations, and temperatures is investigated. A shift function on the basis of thermorheologically simple material is deduced from present results and those by others. Heat treatment of a glass plate is discussed with the phenomenological approach expounded in the paper. The creep results are also checked against a cantilever glass beam sagging due to its own weight at elevated temperatures. Author

N67-14519*# Lehigh Univ., Bethlehem, Pa.
**DYNAMIC MECHANICAL PROPERTIES OF SOME NON-AQUEOUS DISPERSIONS**
Ray D. Hoffman and Raymond R. Myers *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 693–708 refs Sponsored in part by Sun Chemical Corp. (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

A series of dispersions of kaolin clay and calcium carbonate suspended in polybutens and alkyd varnish liquids were formulated. Measurements of the dynamic viscosity and elasticity of these dispersions were made at low deformations in the frequency range from 0.01 to 5 cps. The subject dispersions exhibited properties associated with groupings of long chains of noncrosslinked particles. Treatment of the dispersions to form a gel resulted in highly nonlinear viscoelasticity. The elastic modulus increased with the square of the concentration for all dispersions. The overall temperature dependence of the modulus depended upon the specific nature of the dispersion. It was possible to separate the internal energy from the configurational free energy by simultaneous vertical and horizontal shifting of the modulus-frequency curves. The change in internal energy of the system is concluded to be a function of the viscosity of the suspending liquid alone. Author

N67-14533*# Manchester Univ. (England). Dept. of Textile Technology.
**THE FATIGUE BEHAVIOR OF TEXTILE YARNS**
A. J. Booth and J. W. S. Hearle *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 203–225 refs Sponsored by Army (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

Viscose rayon, acetate, nylon, and Terylene yarns with varying twists have been subject to fatigue tests at various levels of extension, both with and without take-up of slack. Results are presented for the changes in length and stress which occur, and for the number of cycles to break where this occurs. Photomicrographs of broken fibers are included. The results are discussed in terms of elastic recovery of fibers and the nature of the breakage. Author

N67-14535*# Central Lab. TNO, Delft (Netherlands).
**MECHANICAL PROPERTIES OF HIGHLY FILLED ELASTOMERS. I: RELATIONSHIP BETWEEN FILLER CHARACTERISTICS, SHEAR MODULI, AND TENSILE PROPERTIES**
F. R. Schwarzl, H. W. Bree, and C. J. Nederveen *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 241–263 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50
(Contract N62558-2822)

The effect of the size and of the amount of NaCl filler on the mechanical properties of polyurethane rubber was investigated. The tensile tests at room temperature showed that with the increase of filler content the characteristic rubberlike stress–strain curves change shape and exhibit a definite yield point coinciding with the onset of de-wetting. The yield strength was found to increase considerably with the decrease of the filler size. Torsion tests at small strains show that the deformation behavior is chiefly determined by the volume fraction of filler and only slightly depends on filler size. All filled and unfilled samples show a softening region where the shear modulus drops over more than two powers of ten and where the damping passes through a maximum. The position of the softening temperature only slightly depends on amount or size of filler. The levels of the shear moduli in the glassy and rubbery states increase considerably with filler content and were found to be independent of filler size. These levels may be predicted by the theory of Van der Poel from the amount of filler, the shear modulus of the filler and the corresponding level of the unfilled rubber. Author

N67-14536*# Cambridge Univ. (England). Dept. of Chemical Engineering.

**ON THE MELT-FLOW INSTABILITY OF EXTRUDED POLYMERS**

J. R. A. Pearson and C. J. S. Petrie *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 265–282 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

An analysis is carried out for pressure and shear flow of highly viscous fluids in an infinitely long channel; a variable wall slip velocity is taken to be a possible cause of instability and the methods of linearized stability theory are employed. Results have been obtained for Newtonian and for inelastic (Reiner–Rivlin) fluids, in particular for power-law fluids, and an extension to elastic fluids is proposed. The applicability of solutions to channels for tubes of finite length is also investigated. Although the earliest instability appears to occur for zero wave number in most cases, other wave numbers become unstable at higher flow rates and so the variable wall slip mechanism could be relevant in practice. The relation between a melt failure criterion and a boundary slip explanation is discussed. Author

N67-14537*# Kogakuin Univ., Tokyo (Japan).

**STRESS–STRAIN–TIME RELATIONS IN FILAMENTOUS HIGH POLYMERIC MATERIALS**

Yukisaburo Yamaguchi *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 283–299 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The stress–strain–time curved surface has been investigated quantitatively and experimentally to inquire synthetically into four mechanical behaviors in relation to loading time, such as creep, stress relaxation, stress–strain curve due to constant rate of strain, and endurance limit for tensile load in filamentous high polymeric materials. A formula for stress relaxation has bden derived from the creep formula which is also shown geometrically by a stress–strain–time curved surface. It has been made clear that both the formula and the stress–strain–time curved surface which is built up by the creep curves under various constant stresses closely correspond to the experimental relations between stress, strain, and loading time in stress–strain curves under constant rate of strain, and in stress relaxation. Consequently, the methods for obtaining geometrically the stress–strain curve due to any constant rate of strain, creep curve under any constant stress, and stress relaxation curve under any constant strain out of each of these curves have been introduced. Author

N67-14539*# Pechiney-Saint-Gobain, Paris (France). Centre de Recherches de la Croix de Berny.

**RHEOLOGY OF POLYMER MELTS. VISCOELASTIC PARAMETERS AND THEIR INFLUENCE ON FLOW UNDER STATIC CONDITIONS [RHEOLOGIE DES POLYMERES FONDUS. LES PARAMETRES VISCOELASTIQUES ET LEUR INFLUENCE SUR L'ECOULEMENT EN REGIME STATIONNAIRE]**

A. J. De Vries *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 321–344 refs In FRENCH; ENGLISH summary (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The shear stress as a function of shear rate and as a function of time after cessation of flow has been determined for a number of polymer melts by means of the Kepes cone and plate viscometer. The experimental results have been compared with other theoretical expressions. It is shown that one theory is able to predict the shear rate dependence of the apparent viscosity with a reasonable accuracy if the relaxation spectrum is known. The failure of the other two theories to predict correctly the nonlinear behavior in shear is discussed and some arguments explaining this failure are given. The characteristic parameters derived from the relaxation curves have been determined for a number of polymers as a function of the molecular weight and of the molecular weight distribution. The important effect of the molecular characteristics on the rheological behavior of polymer melts is discussed for polystyrene and for high density polyethylene. Author

N67-14540*# Centre de Recherches Physiques, Marseille (France).

**NEW RESEARCH ON THE RHEOLOGY OF HIGH POLYMERS [NOUVELLES RECHERCHES SUR LA RHEOLOGIE DES HAUTS POLYMERER]**

William Bismuth and Jean Saunier *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 345–359 refs In FRENCH; ENGLISH summary (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The phase method is used to study the speed of propagation and the damping of a wave propagated in three samples which were (1) rubber vulcanized with sulfur, (2) rubber vulcanized with dicumyl peroxide, and (3) butyl rubber vulcanized with sulfur. With the aid of an electronic calculator the rheological constants $A_i$ and $B_i$ and the equation of state $f(\sigma,\epsilon,t)=0$ for these viscoelastic samples were determined. The results show that if certain constants (Young's modulus, time of relaxation) are of the same order for the three rubbers, others are completely different. A preliminary theory based on the molecular configuration of these rubbers is given. Author

N67-14541*# Physikalisch-Technische Bundesanstalt, Brunswick (West Germany).

**THE DEPENDENCE OF RELAXATION TIMES ON FREE VOLUME IN HIGH POLYMERS**

Jan Koppelmann *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 361–377 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The shift of the mechanical and dielectric relaxation maxima of polyvinyl chloride is presented over a large range of frequency, temperature, and pressure. The experimental results disagree with the assumption of Williams, Landel, and Ferry that the free volume alone is a measure for the viscosity and the relaxation time of high polymeric substances. It is shown that an extension of the Eyring theory leads to a better physical interpretation of the relaxation behvaior of high polymers. Author

N67-14542*# Sydney Univ. (Australia). Dept. of Mechanical Engineering.

**MEASUREMENTS OF THE SECOND NORMAL STRESS DIFFERENCE IN POLYMER SOLUTIONS**

J. W. Hayes (Roy. Mil. Coll., Duntroon, Australia) and R. I. Tanner *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 389–399 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

In the simple shear flow of a polymer solution defined by the velocity field $v=(\gamma x_2, 0, 0)$ the behavior of the second normal stress difference $p_{22}-p_{33}$ based on the flow in an annulus is described. This involves the measurement of the difference in pressure between inner and outer annulus walls. Results for solutions of polymethyl methacrylate (molecular weight 7 and 10.5 million) in toluene indicate that $p_{22}>p_{33}$, and that $p_{22}-p_{33}$ may be up to about 30% of the shear stress $p_{12}$. The dependence of the normal stress difference on the shear rate $\gamma$ may be roughly expressed by a power-law relation; i.e., $(p_{22}-p_{33})=K_2|\gamma|^m$, where $K_2$ and m are positive constants. Author

N67-14543*# Bundesanstalt fuer Materialpruefung, Berlin (West Germany).

**EXPERIMENTAL RESULTS OF NORMAL STRESS EFFECT [EXPERIMENTELLE ERGEBNISSE ZUM NORMALS-PANNUNGSEFFEKT]**

K. Kirschke *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 401–415 refs In GERMAN; ENGLISH summary (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The rapid shearing characteristics of polymers dissolved in mineral oil are considered. The free surface shape in a spinning cylinder already indicated a normal stress effect for dissolved polyisobutylene. Quantitative results are obtained with shearing between rotating parallel plates, for which, due to normal stresses, an axial force is needed to maintain a steady state. The influences of polymer concentration, polymerization, angular velocity, temperature, and fluid layer dimensions were studied for several polymers. The pure oils used exhibited Newtonian viscosity. Application of these results to lubrication technology is also discussed. Author

**N67-14546*#** Badische Anilin- und Soda-Fabrik AG, Ludwigshafen am Rhein (West Germany). Mess- und Prueflaboratorium.

**THE EFFECT OF TEMPERATURE ON THE FLOW PROPERTIES OF THE LOW DENSITY POLYETHYLENE MELT**

Joachim Meissner *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 437–453 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The temperature dependence of viscous and elastic properties of a low density polyethylene melt was determined in the temperature range from 125° to 240°C at shear rates from $10^{-4}$ to $10^{+4}$ $sec^{-1}$. Below a certain shear stress the material behaves like a Newtonian fluid. At higher shear stresses different deviations from the Newtonian flow begin in a relatively narrow range of shear stresses. At shear rates from 1 to $10^{4}$ $sec^{-1}$ a capillary viscometer was used in connection with special equipment for the seapartion of the elastic and the viscous data. The variation of the viscosity as a function of temperature can be described by an Arrhenius equation. This is true even in the non-Newtonian range if the viscosity variation is treated at constant shear stress. The activation constant $E_\gamma$ was found to decrease with increasing shear action. A corresponding Arrhenius relation for constant shear rate is not valid. The temperature dependence of the elastic properties of the streaming polyethylene melt is only slight and corresponds to the temperature behavior of a rubber-like material. Author

**N67-14548*#** National Technical Univ., Athens (Greece). Lab. for Testing Materials.

**VISCOELASTIC BEHAVIOR OF PLASTICIZED EPOXY POLYMERS IN THEIR TRANSITION REGION**

P. S. Theocaris and Chr. Hadjijoseph *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 485–500 refs Sponsored by Roy. Hellenic Found. of Res. (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The influence of a plasticizer added to a pure cold-setting epoxy polymer was investigated by testing the copolymers in creep and relaxation at various temperatures. Master curves were defined expressing the time variation of creep compliance, relaxation modulus, stress–optical coefficient, and strain–optical coefficient of all copolymers studied. The values of the time factor and the apparent activation energy were determined and plotted. The characteristic mechanical and optical viscoelastic properties of these materials were derived from these tests. The investigation showed the validity of the time–temperature superposition principle for the mechanical viscoelastic properties of all the polymers, as well as their optical properties, defined by the stress and strain–optical coefficients in creep and relaxation. It was also shown that the addition of plasticizer had the same effect as a rise in temperature. L.E.W.

**N67-14549*#** Kyoto Univ. (Japan). Dept. of Polymer Chemistry.

**THE ELASTICITY OF LOW DENSITY POLYETHYLENE**

Kiyohisa Fujino, Hiromichi Kawai, Takashi Oda, and Hiroshi Maeda (Kanagafuchi Spinning Co., Ltd., Osaka) *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 501–523 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The elasticity of low density polyethylene, a typical semicrystalline polymer, was investigated in terms of response of crystalline and noncrystalline phases, i.e., in terms of the change of orientations of three crystallographic axes and of the methylene unit in the noncrystalline phase. These were evaluated from simultaneous measurements of X-ray diffraction and birefringence of the specimen at stretched and released (relaxed) states. Author

**N67-14551*#** Tokyo Univ. (Japan). Aeronautical Research Inst.

**VISCOELASTIC PROPERTIES OF CONCENTRATED DISPERSIONS IN A MOLTEN POLYMER**

Hirotaro Kambe and Masaharu Takano *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 557–572 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

Dynamic properties of molten polyethylene with fillers were measured at frequencies from 0.01 to 0.75 cycle/sec. A torsionally oscillating cone and plate rheometer was devised for measurements at 150 to 230°C. Glass spheres, calcium carbonate, and barium sulfate powders were used as fillers. The diameter of particles covered the range of 0.04 to 90 $\mu$. Viscoelastic properties of polyethylene were enhanced by fillers. Their values at lower frequencies with different fillers varied differently with the concentration. In suspensions of larger glass spheres, concentration dependence of dynamic viscosity followed Robinson's formula. In suspensions of calcium carbonate of intermediate size, more noticeable dependence was observed. In suspensions of smaller calcium carbonate and barium sulfate, dynamic viscosity and modulus increased appreciably above a critical concentration of the filler. Temperature dependence of dynamic viscosity at lower frequencies agreed with that of unfilled polymer. Dependence of dynamic properties on time and on amplitude of oscillation was observed in calcium carbonate and barium sulfate suspensions of smaller particles. Author

**N67-14552*#** Rochester Univ., N. Y. Coll. of Engineering and Applied Science.

**ON THE VISCOSITY OF THIXOTROPIC SUSPENSIONS**

H. D. Weymann *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 573–591 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

A theory is developed for the viscosity of thixotropic suspensions at medium and large shear rates. The calculations are based on the assumptions that some of the suspended particles form loose spheroidal aggregates in which the dispersive phase is immobilized and that, even at finite shear rates $\dot{\gamma}$, the nonaggregated phase has the viscosity $\eta_\infty$ which the whole suspension exhibits at infinite shear rate. The volume fraction of all aggregates is calculated to be $\phi = T_0/(2.5\,\eta_\infty\dot{\gamma})$ with $T_0$ a constant depending on the concentration and the temperature. Applying Einstein's relation for the viscosity of suspensions gives $\tau/\dot{\gamma} = \eta = \eta_\infty[1 + T_0/(\eta_\infty\dot{\gamma})]$ for thixotropic suspensions. This is equivalent to the experimentally found Bingham behavior. Author

**N67-14553*#** Newcastle Univ. (England). Dept. of Physics.

**MEASUREMENTS ON THE TEMPERATURE VARIATION OF THE RIGIDITY OF GELS**

R. Roscoe *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 593–604 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The gel can be kept under constant stress while observations are made on change of strain with temperature. If the temperature is kept below its original level, the influence of bond formation and breakage is small and can be made negligible by using rapid temperature changes; thus, the measurements give the variation of rigidity of the original gel structure. Elementary theory suggests that the temperature coefficient should be positive and equal to the reciprocal of the absolute temperature (0.0034/°C.) when the

rigidity arises from decrease of configurational entropy on deformation, and much smaller when it arises from increase in internal energy. However, constant stress measurements made with a concentric cylinder apparatus give values appreciably higher than 0.0034/°C. for gelatin–water gels and rice–starch pastes. A suspension of Wyoming bentonite gave very little change in rigidity with temperature, while an aluminum stearate gel gave a coefficient of −0.005/°C. Author

N67-14554*# Wall (T.) and Sons (Ice Cream), Ltd., London (England).
**AN EQUATION FOR THE NEWTONIAN CONTRIBUTION TO PSEUDOPLASTIC FLOW IN CONCENTRATED DISPERSIONS**
Philip Sherman *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 605–620 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

Equations for the viscosity of solid particle dispersions or emulsions make no allowance for the effect exerted by particle size. A semi-empirical method is proposed whereby this omission can be remedied when interpreting pseudoplastic flow at high rates of shear and also Newtonian flow in moderately concentrated systems. This is based on the analysis of viscosity data for dispersions and emulsions with well-defined particle size distributions. It is shown that the apparently anomalous viscosity of oil/water emulsions, which hitherto was attributed to an electroviscous effect, may be due to particle size fluctuations having been ignored. Author

N67-14558*# Sydney Univ. (Australia). Dept. of Medicine.
**THIXOTROPY AND DILATANCY IN COMPLEX MULTIPHASE EMULSIONS AND SUSPENSIONS**
Leopold Dintenfass *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 621–632 refs (Sponsored by the Natl. Health and Med. Res. Council of Australia (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

A microrheological classification of complex fluids is suggested. The molecular and the colloidal structures of the phases and subphases are related to viscosity, thixotropy, and dilatancy of these phases and subphases, and to the rheology of the composite suspension. The internal rheology of drops is taken into account. This classification allows one to obtain a picture of the structure of the fluid investigated from the flow curves observed, and permits one to explain the rheological behavior of a complex fluid from the known behavior of its components. Author

N67-14674# Human Engineering Labs., Aberdeen Proving Ground, Md.
**CREW-COMPARTMENT TEMPERATURES: THE EFFECTS OF A SOLAR-HEAT REFLECTING PAINT**
R. Bradley Randall Jul. 1966 43 p refs
(TN-4-66; AD-640155) CFSTI: HC $2.00/MF $0.50

The study evaluated an olive-drab enamel that reflects solar heat. The evaluation compared temperatures inside two M113 Armored Personnel Carriers (APCs): one painted with the reflecting paint and the other with a conventional lusterless olive-drab finish. Over a five-day period, measurements at five locations on each APC revealed that temperatures were lower in the vehicle treated with the reflecting paint. Because this paint reduces the temperature of the vehicular skin and of the crew-compartment air, it will probably reduce the thermal stress on personnel confined inside such vehicles. If this paint is used with air-conditioned vehicles, it should reduce air-conditioning requirements. Author (TAB)

N67-14676# Rock Island Arsenal Lab., Ill. Research and Engineering Div.
**INTERFERENCE MICROSCOPIC EXAMINATION OF FLUID FILMS ON METAL SURFACES**
Bernard J. Bornong Jun. 1966 36 p refs
(RIA-66-2048; AD-639951) CFSTI: HC $2.00/MF $0.50

Profiles of fluid films on metal surfaces were measured by means of interference microscopy. The purpose of the work was to further characterize the behavior of fluid films and adsorbed films on metals in terms of molecular structure of the fluid components, surface topography and surface energy. The method used was similar to one described by Bascom, Cottington and Singleterry of the Naval Research Laboratory. Film profiles were measured down to thickness of about 1000 angstroms by this method. The results confirmed the mechanism for spreading of liquids which was advanced by Bascom and co-workers. Squalene films containing 0.01% by weight oleic acid did not spread on polished stainless steel or platinum. Films containing 0.01% by weight and 0.3% by weight oleic acid did spread on platinum, but at a slower rate than did the pure squalene. Results are interpreted in terms of known surface energy relationships. Effects of surface contamination by particles and by adsorbed films can be readily observed by the method of interference microscopy. Under some conditions the micro-relief structure of the metal surface can also be observed and estimates made of the heights of the surface elevations. Author (TAB)

N67-14723# Naval Research Lab., Washington, D. C. Organic and Biological Chemistry Branch.
**MICROPARTICLE AND FIBER REINFORCEMENT OF EPOXY RESINS Interim Report**
A. G. Sands, R. C. Clark, and E. J. Kohn 26 Aug. 1966 15 p refs
(NRL-6403; AD-640054) CFSTI: HC $1.00/MF $0.50

Microparticle and fiber materials have been investigated as reinforcing agents for a diglycidyl ether of bisphenol a type of epoxy resin. These materials were limited to low concentrations in order to insure retention of the resin binder properties, such as viscosity and pot life, required for glass-filament-winding processes. In general the material screened did not substantially improve the compression properties of the cast resin as compared to the best unfilled controls. The greatest improvement was achieved with colloidal boehmite alumina and Hi-Sil X303 silica, when the stoichiometric amount of amine curing agent was used. The alumina was superior to the silica in increasing the resin modulus of toughness, but the silica gave higher values for the compression yield and ultimate strengths. The highest values for the compression properties of the unfilled resin controls were obtained when 78% of the stoichiometric amount of m-phenylene diamine (CL) curing agent and a critical B stage curing temperature were used. As indicated by a limited study, flaw sensitivity or surface imperfections may significantly influence the compression strength of unfilled cast resin test specimens, whereas these effects were negligible with specimens containing Hi-Sil X303 silica. Experiments to determine the effect on the interlaminar shear strength of glass-filament NOL rings wound with resins containing colloidal boehmite alumina and Hi-Sil X303 silica were inconclusive because of the high void content of state-of-the-art wound NOL rings. Author (TAB)

N67-14784*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**POLYMERS FOR USE IN STERILIZED SPACECRAFT**
Donald P. Kohorst and Herman Harvey *In* NASA. Washington Spacecraft Sterilization Technol. 1966 p 327–342 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

A test program was initiated to evaluate polymer products for potential application on the Voyager landing capsule. The

program consists of exposing products to 300°F for three cycles of 40 hours each, and 12% ethylene oxide and 88% Freon 12 mixture for two periods of 24 hours. Property measurements are made before and after exposure to determine changes in strength, hardness, volume, electrical resistivity, dielectric strength, tear strength, compression set and adhesion. The tests applied to each class of products vary depending on product application. The classes of material tested in the program included adhesives, coatings, encapsulating compounds, elastomers, reinforced and unreinforced plastics, films, and tapes. Results indicate heat sterilization to be a much more damaging environment than ethylene oxide. About 20 to 25% of the materials evaluated are considered unacceptable after heat sterilization. Only two have been appreciably degraded by ethylene oxide. Author

**N67-14914*#** Lockheed Missiles and Space Co., Palo Alto, Calif. Aerospace Sciences Lab.
**EMISSIVITY COATINGS FOR LOW-TEMPERATURE SPACE RADIATORS** Quarterly Progress Report, 1 Jan.–31 Mar. 1966
F. J. Smith and J. G. Grammer 31 Mar. 1966 37 p refs
(Contract NAS3-7630)
(NASA-CR-72060; QPR-3) CFSTI: HC $3.00/MF $0.65 CSCL 11C

The initial optical properties, solar absorptance, and emittance of two candidate coating samples, ZnO/silicone and $ZnO/K_2SiO_4$ were measured at room temperature, and the data are tabulated. Typical ultraviolet spectral reflectance curves for the coatings are presented. Progress regarding the spectral radiometer apparatus used for the tests is also reported. A thermal profile for the thermal cycling testing was established; the specific heat of a sample substrate was determined; a tungsten iodide lamp was spectrally calibrated; and the feasibility of in situ broad band spectral absorptance measurements was theoretically investigated. L.S.

**N67-15019#** Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Metallurgy and Materials Science.
**THE FRACTURE TOUGHNESS OF IMPURE MgO CRYSTALS**
Geoffrey W. Groves and Donald A. Shockey Nov. 1966 26 p refs
(Contract Nonr-760(29))
(TR-2; AD-641657) CFSTI: HC $2.00/MF $0.50

When cracks are propagated through impure MgO crystals in a series of small jumps, the force needed to initiate successive jumps decreases as the crack grows in the manner predicted by a Griffith energy balance, in which an effective, or fracture surface energy is substituted for the true surface energy of the crystal. Fracture surface energies in the range 1000 to 3000 ergs/sq cm are obtained. Examination of the fracture surfaces shows that many dislocations are introduced by the crack as it comes to the end of a jump. The measured fracture surface energy represents the release of elastic energy which is needed to re-start a crack from a plastically deformed configuration. When the crack divides the crystal into unequal instead of equal parts, a different pattern of slip occurs at its tip, which leads to a higher fracture surface energy. Author (TAB)

**N67-15096#** Naval Research Lab., Washington, D. C.
**PHOTODEGRADATION OF HIGH POLYMERS IN SOLUTION. PART 3: POLYMETHYL POLYMETHACRYLATE** Interim Report
R. B. Fox and T. R. Price 7 Sep. 1966 25 p refs
(NRL-6423; AD-642177) CFSTI: HC $3.00/MF $0.65

The photodegradation of poly(methyl methacrylate) in solution in the presence and absence of air under 2537A irradiation at about 25C was investigated, primarily by means of viscosity measurements. Random scission is confirmed as the major chain-breaking process. Quantum yields for scission in degassed solutions are solvent dependent; for methylene chloride, dioxane, and ethyl acetate, the quantum yields are 0.15, 0.17, and 0.38, respectively. In methylene chloride the quantum yield is nearly independent of polymer concentration and decreases slightly with increasing absorbed radiation intensity. Small amounts of benzene tend to increase the quantum yields, but carbon tetrachloride has relatively small effect and does not sensitize the degradation. In any of the solvents in the presence of air the quantum yields are approximately half of those found in the absence of air. Adventitious peroxides appear not to play a role in the degradation, but an oxygenated sample which probably contains peroxides acts initially as a sample would in air. The results can be interpreted in terms of possible electronic energy transfer processes. Author (TAB)

**N67-15283#** Lexington Labs., Inc., Cambridge, Mass.
**RUBIES FOR REFERENCE TEMPERATURE STANDARDS** Final Report, 7 Apr. 1965–6 Apr. 1966
Philip S. Schaffer Griffiss AFB, N. Y., RADC. Sep. 1966 53 p refs
(Contract AF 30(602)-3745)
(RADC-TR-66-456; AD-640177) CFSTI: HC $3.00/MF $0.50

The vapor-phase growth technique was further developed for the growth of sapphire and ruby single crystals. Impurity content below 3 ppm was attained. Electron-microprobe technique was improved and used to demonstrate chromium doping uniformity of plus or minus 5ppm. Author (TAB)

# 19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

**N67-14346#** Joint Publications Research Service, Washington, D. C.
**PROBLEMS OF OPTIMAL DISTRIBUTION OF LIMITED RESOURCES**
I. N. Kuznetsov *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 46–55 refs (See N67-14341 05-10)

The algorithm is described for finding the optimal distribution $y_0(x)$ of a limited amount of resources Y with respect to the space X, in which the payoff function F(y, x) is defined. The payoff function for any $x = X$ is assumed to be differentiable with respect to y everywhere with the exception of the finite or denumerable set of break and discontinuity points. Author

**N67-14347#** Joint Publications Research Service, Washington, D. C.
**QUEUEING SYSTEMS WITH LIMITED CHANNEL RESOURCES**
A. Ya. Ioffe *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 56–72 refs (See N67-14341 05-10)

The fundamental properties of the systems are summarized, and the two basic types are identified as systems with parallel reception, and with sequential reception. From the viewpoint of practical application, a theoretical solution is presented to the problem of a homogeneous system with single action channels. The probability model used is a simple homogeneous Markov chain with a finite number of states. To illustrate the procedure, an example is given in which the operation of a group of antiaircraft media for repelling bomber attacks is investigated. M.G.J.

N67-14348# Joint Publications Research Service, Washington, D. C.
**SEPARATION OF THE NOISE OF PULSE FLOWS WITH A RESTRICTED AFTEREFFECT. I: MATHEMATICAL APPARATUS**
A. L. Grigor'yev and I. A. Bol'shakov *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 73-90 refs (See N67-14341 05-10)

The mathematical apparatus of the generating functionals is developed for the solution of the problem of separation from noise of pulse flows with a limited aftereffect (recovery flows). The conditional generating functionals are introduced; the integral relationships and expressions are found for them with unconditional functionals. On the basis of this, multidimensional functions of the flow density and the generating functions of the number of losses are investigated. A number of examples are studied. Author

N67-14349# Joint Publications Research Service, Washington, D. C.
**TAKING INTO ACCOUNT THE POSSIBILITY OF FAILURE AND REPAIR OF A SINGLE-LINE QUEUEING SYSTEM**
V. A. Ivnitskiy *In its* Tech. Cybernetics, No. 5, 1966 3 Jan. 1967 p 91-105 refs (See N67-14341 05-10)

A single-line queueing system with a queue is investigated. The intensity of the input flow and the servicing rate depend on the length of the queue. The servicing system may go out of order and be repaired both in the free and in the busy states. For stationary distribution of the length of the queue $P_i$ recurrent formulas are obtained. The sufficient condition for existence of stationary distribution is found. Author

N67-14400*# Innsbruck Univ. (Austria).
**THE SOLUTION OF A SYSTEM OF N-TH-ORDER DIFFERENTIAL EQUATIONS USING LIE SERIES**
F. Cap and D. Floriani 25 Nov. 1966 8 p ref
(Grant NGR-52-046-001)
(NASA-CR-80870; SR-12) CFSTI: HC $1.00/MF $0.50 CSCL 12A

The solution of a system of n-th order ordinary differential equations which is solved for $y_0^{(n)} = f_0(x, y, y', \ldots, y^{n-1})$ is obtained by means of the Lie series as introduced by Groebner. For this purpose, the concept of a "Lie series" is defined initially and some important properties are quoted. In the third part, the system of equations is solved. Author

N67-14407*# Wisconsin Univ., Madison.
**SPECIAL COMPUTATIONAL PROCEDURES FOR DIFFERENTIAL EQUATIONS**
S. V. Parter *In its* Lectures in Appl. Math. Vol. 7: Space Math., Pt. 3 1966 p 179-205 refs (See N67-14401 05-12) CFSTI: HC $7.00/MF $1.50

An analytical study of ordinary and differential equations for solving problems in applied mathematics is presented. The initial value problem is discussed with respect to single- and multi-step methods. Practical problems are illustrated using the heat equation and an elliptic equation. Stability and convergence are emphasized, and the inversion of large matrices is described. N.E.N.

N67-14408*# Washington Univ., Seattle.
**THE TWO VARIABLE EXPANSION PROCEDURE FOR THE APPROXIMATE SOLUTION OF CERTAIN NONLINEAR DIFFERENTIAL EQUATIONS**
J. Kevorkian *In* Wis. Univ. Lectures in Appl. Math. Vol. 7: Space Math., Pt. 3 1966 p 206-275 refs (See N67-14401 05-12) CFSTI: HC $7.00/MF $1.50

An expansion procedure is presented in which two dimensionless time-like variables, whose ratio is the small parameter of the problem, are introduced explicitly in the calculations. The two times are treated as distinct independent variables, and the initial value problem for an ordinary differential equation is transformed to one involving a partial differential equation in two times. The asymptotic solution of the transformed problem involves certain indeterminate functions which are defined by postulating that the problem possesses a consistent asymptotic expansion uniformly valid for times of the order of the reciprocal of the small parameter. It is shown that with the proper choice of variables, the two variable expansion procedure is applicable even to those cases where no general results are available. The bounded oscillation problem is formulated, and linear and nonlinear examples are given. Applications for satellites are discussed for the planar motion with aerodynamic perturbations of a satellite orbit and the motion of a close satellite in the restricted three-body problem. N.E.N.

N67-14412*# Yale Univ. Observatory, New Haven, Conn.
**MATRIX METHODS**
J. M. A. Danby *In* Wis. Univ. Lectures in Appl. Math. Vol. 5: Space Math., Pt. 1 1966 p 32-39 refs (See N67-14410 05-30) CFSTI: HC $6.00/MF $1.50

Partial differential equations and the matrix method are discussed, and are applied to orbital motion. Permissible error from a reference orbit is mentioned, and equations of motion are developed. N.E.N.

N67-14413*# Ballistic Research Labs., Aberdeen Proving Ground, Md.
**THE LAGRANGE-HAMILTON-JACOBI MECHANICS**
Boris Garfinkel *In* Wis. Univ. Lectures in Appl. Math. Vol. 5: Space Math., Pt. 1 1966 p 40-76 refs (See N67-14410 05-30) CFSTI: HC $6.00/MF $1.50

The mathematical theory is discussed and is applied to the Kepler two-body problem as an example of a separable system. Canonical transformation, conditional periodicity, the Kepler orbital elements, and equations of variation are included. N.E.N.

N67-14415*# General Precision, Inc., Little Falls, N. J. Aerospace Research Center.
**LECTURES ON REGULARIZATION**
Paul B. Richards *In* Wis. Univ. Lectures in Appl. Math. Vol. 5: Space Math., Pt. 1 1966 p 100-118 refs (See N67-14410 05-30) CFSTI: HC $6.00/MF $1.50

The existence and uniqueness theorems of ordinary differential equations are considered, and the application of the regularization method at the singular point of the differential equation is indicated. The regularization is discussed for the relative n-body equations of celestial mechanics and for the relative three-body equations in the case of binary collisions, using Sundman's transformation. N.E.N.

N67-14418# Iowa State Univ. of Science and Technology, Ames.
**RESEARCH REPORT IN MATHEMATICS AND COMPUTER RESEARCH**
F. H. Spedding, B. C. Carlson, D. R. Fitzwater, and R. M. Stewart *In its* Chem., Eng., Met., Phys. and Reactor Div. Jul. 1966 9 p refs (See N67-14812 05-34) CFSTI: HC $7.94/MF $2.25

Summary reports are presented in mathematics and computer programming research. Brief discussions are included on: a two parameter homogeneous mean value, a property of the hypergeometric mean value, computation of elliptic integrals, and hypergeometric functions. Programming research consisted of studies in real time control systems, selective dissemination of information, and language development. S.P.

N67-14637*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**COMPUTATION RESEARCH**
Martha M. Pennell and Heather Davis *In its* Res. Lab. of Electron. 15 Oct. 1966 p 179–181 (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25
(Contract DA-36-039-AMC-03200(E))

The application of the method of the least squares in linearizing the roots of a polynomial is demonstrated by way of an example. Numerical results are presented in two tables, the first of which gives approximation of the root with the largest magnitude using 8 and 12 points, while the same calculations of a different set of 8 and 12 points are repeated in the other table. K.W.

N67-14708# Harvard Univ., Cambridge, Mass. Dept. of Statistics.
**GENERALIZED EXCHANGEABILITY OF RANDOM VARIABLES**
Jay R. Goldman 30 Sep. 1966 6 p refs
(Contract Nonr-1866(37))
(TR-11; AD-640159) CFSTI: HC $1.00/MF $0.50

It is shown that by weakening the type of invariance usually assumed for exchangeable random variables, the exchangeability is still preserved. Author (TAB)

N67-14730# Syracuse Univ., N. Y. Dept. of Electrical Engineering.
**MATRIX METHODS FOR SOLVING FIELD PROBLEMS. VOLUME I: MATRIX TECHNIQUES AND APPLICATIONS**
Final Report
Roger F. Harrington, Long-Fei Chang, Arlon T. Adams, Robert Wallenberg, and Thomas Bristol Griffiss AFB, N. Y. RADC. Aug. 1966 183 p refs
(Contract AF 30(602)-3724)
(RADC-TR-66-351, Vol. I; AD-639 744) CFSTI: HC $5.00/MF $1.00

The report presents general procedures for solving field problems of engineering interest using digital computer techniques. The basic concept is to represent a boundary-value problem by a superposition integral, approximate the integral equation by a matrix equation, and invert the matrix for a solution. The theory is described in terms of the method of moments, which is equivalent to the variational method. For electromagnetic antenna and scattering problems, the method gives a matrix whose elements can be interpreted as generalized impedances. These impedances are closely related to those used in the theory of loaded antennas and scatterers, and hence such loaded structures can also be treated. A solution for wire antennas and scatterers of arbitrary shape is formulated in detail, and calculations for linear wire antennas and scatterers, both loaded and unloaded, have been made. Additional problems treated by these procedures are two-dimensional scattering by conducting cylinders and by dielectric cylinders, and three-dimensional scattering by bodies of revolution. These problems are used to show the effect of various approximations in the solution, in an attempt to draw some general conclusions as to the best approximations. Special procedures for inverting matrices have also been considered, to take into account any symmetry properties present in the matrices. A considerable saving in computation time can often be made by property utilizing these symmetries. Author (TAB)

N67-14737# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
***LINEARIZATION OF THE EQUATIONS OF MOTION OF AUTONOMOUS SYSTEMS WITH THE AID OF ASYMPTOTIC POLYNOMIALS***
G. O. Yaroshevich 18 Aug. 1966 7 p refs Transl. into ENGLISH from Izv. Vysshikh Uchab. Zavedenii, Mat. (Moscow), no. 6(49), 1965 p 176–179 refs
(Contract NOw-62-0604-c)
(TG-230-T497; TT-66-62386; AD-639911) CFSTI: HC $1.00/MF $0.50

An effective method is proposed in this paper for constructing the fundamental harmonic of the solution of the nonlinear equation of motion of an autonomous system and a suitable stability criterion is proved. The method is based on the apparatus of approximation of functions recently developed by I. I. Eterman. Systems with one degree of freedom are considered. Author (TAB)

N67-14750# Polytechnic Inst. of Brooklyn, N. Y. Microwave Research Inst.
**INVARIANT ESTIMATION OF STOCHASTIC SYSTEM PARAMETERS**
Guner Suzek and Leonard Shaw May 1966 62 p refs
(Contract DA-31-124-ARO(D)-316)
(PIBMRI-1334-66; AROD-5211.3; AD-640020) CFSTI: HC $3.00/MF $0.75

The report is concerned with the estimation of the statistics of a class of random processes. Properties of a new constant risk estimator of the autocorrelation function for exponentially correlated processes are studied analytically. The results are applied to computer-generated random processes and the estimates found are compared with the results of more common estimation methods, such as autoregressive estimation. The effect of increasing the amount of data and changing the input distribution is examined both analytically and experimentally. Author (TAB)

N67-14753# RAND Corp., Santa Monica, Calif.
**MAXIMAL CONSISTENT FAMILIES OF TRIPLES**
Joel Spencer Sep. 1966 20 p refs
(Contract AF 49(638)-1700; Proj. RAND)
(RM-5128-PR; AD-640304) CFSTI: HC $1.00/MF $0.50

A family F of three element subsets of an n-element set Sn is called n-consistent if the intersection of any two sets of F contain at most one element of Sn. We find maximal (in number of elements) F for all n. For certain n the F are Steiner Triple Systems. The construction of the F is constructive. Structure Theorems are given determining the graph of doublets not covered by triplets in F. Author (TAB)

N67-14757# California Univ., Berkeley. Operations Research Center.
**MULTI-COMMODITY NETWORK SOLUTIONS**
William S. Jewell Sep. 1966 18 p refs Presented at the Intern. Seminar on Graph Theory and Its Appl., Rome, 5–9 Jul. 1966; Sponsored by Intern. Computation Center
(Contracts Nonr-222(83); DA-31-124-ARO-(D)-331; Grant NSF GP-4593)
(ORC-66-23; AD-639672) CFSTI: HC $1.00/MF $0.50

Multicommodity network flow problems have rational optimal solutions, in general, because the constraint matrix is not unimodular. Thus, all algorithms proposed to date require solving the equivalent of a general linear program in order to allocate the mutual capacities correctly, and it is here that fractional solutions may arise. This paper attempts to characterize the nature of these rational solutions by presenting several conjectures about the modularity of multicommodity flow problems. Fundamental difference between the directed- and undirected-arc case are revealed, as well as the important role played by individual capacity constraints. Further investigations seems to require the development of new combinatorial and graph-theoretic methods. Author (TAB)

N67-14841# RAND Corp., Santa Monica, Calif.
**AN ANALYSIS OF THE TWO-DIMENSIONAL PARTICLE-IN-CELL METHOD**
M. A. Kaplan and R. A. Papetti Sep. 1966 57 p refs
(Contract AF 49(638)-1700; Proj. Rand)
(RM-4876-PR; AD-641655) CFSTI: HC $3.00/MF $0.50

Final results are given for an investigation of the nature of the errors that arise in the course of Particle-In-Cell (PIC) computation process. Among the important conclusions are that the dominant error terms bear only a casual relation to physical effects; that a pseudostress can be constructed that gives rise to the dominant errors in the momentum equation and to some of the errors in the energy equation associated with the gradients of the fluid velocity; and that the axisymmetric elements of the pseudostress suggest that the PIC equations contain errors that lead to effects associated with polar fluids. Author (TAB)

N67-14844# Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics.
**A BAYESIAN STUDY OF THE MULTINOMIAL DISTRIBUTION**
D. A. Bloch and G. S. Watson Oct. 1966 40 p refs
(Contract Nonr-4010(09))
(TR-59; AD-641800) CFSTI: HC $2.00/MF $0.50

Lindley (Ann.Math.Stat. 1964) studied the topic in the title. By using Fisher's conditional-Poisson approach to the multinomial and the logarithmic transformation of gamma variables to normality, he showed heuristically that linear contrasts in the logarithms of the cell probabilities theta sub i are asymptotically jointly normal and suggested that the approximation can be improved by applying a correction to the sample. By studying the asymptotic series for the joint distribution, we have verified this assertion and found an improved correction procedure. A more detailed expansion is given for the distribution of a single contrast. In many problems linear functions of the theta sub i are of interest. The exact distribution for these is obtained. This has a density of a form familiar in the theory of serial correlation coefficients. A beta approximation is given. For three cells, a numerical example is given to show the merit of this approximation. The exact joint distribution of two linear functions of the theta sub i is also obtained and the theory is applied to a genetic linkage example. Author (TAB)

N67-14946# Wisconsin Univ., Madison. Dept. of Statistics.
**THE USE OF PRIOR DISTRIBUTIONS IN THE DESIGN OF EXPERIMENTS FOR PARAMETER ESTIMATION IN NON-LINEAR SITUATIONS: MULTIRESPONSE CASE**
Norman R. Draper and William G. Hunter May 1966 14 p refs
(Contract Nonr-1202(17); Grant NSF GP-2758)
(TR-75; AD-640918) CFSTI: HC $1.00/MF $0.50

When prior information is available on the parameters of a nonlinear model, it should influence the choice of the appropriate experimental design. The authors investigate, for the multiresponse case, how prior information on the parameters in the form of a multivariate normal distribution can be used in selecting designs for parameter estimation. An example illustrates how the precision of the prior knowledge can affect the positioning of the design points. Author (TAB)

N67-14988# Carson Labs., Inc., Bristol, Conn.
**ANALYSIS OF ADAPTIVE LOGIC OPTIMIZATION** Final Scientific Report, 1 May 1965–30 Jun. 1966
Sidney Auslender 30 Jul. 1966 22 p refs
(Contract AF 49(638)-1567)
(AFOSR-66-1848; AD-642409) CFSTI: HC $3.00/MF $0.65

A concept for adaptive processing of information is presented in which heuristic reasoning, normally applied to problems to permit adaptive recognition, is in this case applied to the design of the system to perform adaptation and to learn the problem. Certain similarities exist between the present approach to adaptive processing and other published work on pattern recognition in which geometrical hypersurfaces are generated to provide differentiation. It is contended that the present work provides a more general approach toward learning, in that no built-in assumptions concerning the properties of the environment or the problems to be presented are required. Author (TAB)

N67-14969# Stanford Univ., Calif. Dept. of Statistics.
**ADMISSIBLE BAYES PROCEDURES AND CLASSES OF EPSILON BAYES PROCEDURES FOR TESTING HYPOTHESES IN A MULTINOMIAL DISTRIBUTION**
Carl Morris 11 Aug. 1966 141 p refs
(Contract Nonr-225(72))
(TR-55; AD-642636) CFSTI: HC $3.00/MF $0.65

The purpose of the paper is to further study the problem of testing a simple hypothesis in a multinomial distribution. It is shown that for large K and near alternatives that for testing simple hypotheses one only need consider test procedures which have quadratic forms in $N = (N_1, ..., N_K)$ as test statistics. A central limit theorem is proven for sums of quadratic forms of multinomials. Finally it is shown that the chi-square test, likelihood ratio test and all quadratic forms are bayes and admissible for fixed K and N. Author (TAB)

N67-14973# RAND Corp., Santa Monica, Calif.
**SIMULTANEOUS INTERPOLATION AND PARAMETER ESTIMATION**
William E. Hoehn (Ph.D. Thesis—Northwestern Univ.) Oct. 1966 194 p refs Sponsored by Ford Found. and Social Sci. Res. Council
(P-3338; (AD-642287) CFSTI: HC $3.00/MF $0.65

Contents: The background of simultaneous interpolation and estimation theory; simultaneous interpolation and estimation of values in a single equation model; practical estimation procedures and some numerical examples for single equation models; simultaneous interpolation and estimation in simultaneous equation systems. Author (TAB)

N67-14992# Harvard Univ., Cambridge, Mass. Cruft Lab.
**A GENERAL SAMPLING THEOREM**
J. Budelis and N. Abramson Jun. 1966 18 p refs
(Contract Nonr-1866(16))
(TR-505; AD-640668) CFSTI: HC $1.00/MF $0.50

The usual form of the sampling theorem states that a function a(t), whose Fourier Transform A(f) vanishes outside the interval (-w, w) may be reconstructed exactly from its values at equally spaced sampling points taken at the Nyquist Rate of 2w points per second. It is also known that a(t) may be reconstructed from its sample values taken at half the Nyquist rate if in addition we use the same number of samples from certain functions derived from a(t) (e.g., its Hilbert Transform or its derivative). In this paper the authors derive necessary and sufficient conditions in order that a(t) may be reconstructed from sample values of rather general functions b sub 1 (t), b sub 2 (t), . . . b sub n (t) where the values of each b sub i (t) are taken at 1/n times the Nyquist rate. In addition, the sampling functions necessary for reconstruction are exhibited directly as the solutions of a linear matrix equation. This result includes as special cases k-derivative sampling, irregular spacing sampling and Hilbert Transform sampling. Author (TAB)

N67-15000# Wisconsin Univ., Madison. Mathematics Research Center.
**THE APPROXIMATE SOLUTION OF FREDHOLM INTEGRAL EQUATIONS OF FIRST KIND**
I. N. Dombrovskaja Apr. 1966 14 p refs Transl. into ENGLISH from Ural. Gos. Univ. Mat. Zap. (Sverdlovsk), v. 4, 1964 p 30–35
(Contract DA-11-022-ORD-2059)
(MRC-652; AD-638627) CFSTI: HC $1.00/MF $0.50

A numerical method for approximating the quasi-solution is developed based on solving finite systems of equations in finite-dimensional subsets M sub n of M. Convergence of the approximations obtained in this fashion to the quasi-solution is proved. Author (TAB)

N67-15004# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
**ON A GENERAL METHOD OF INVESTIGATING BOUNDARY-VALUE PROBLEMS**
A. I. Perov and A. V. Kibenko 14 Oct. 1966 25 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Mat. (Moscow), v. 30, no. 2, 1966 p 249–264
(Contract NOw-62-0604-c)
(TG-230-T505; AD-642625) CFSTI: HC $3 $3.00/MF $0.65

The paper is devoted to application of generalized fixed-point principles to problems involving the existence and uniqueness of the solutions of certain boundary-value problems for systems of ordinary differential equations and fornth order equations. Author (TAB)

N67-15013*# Brown Univ., Providence, R. I.
**LIAPUNOV'S SECOND METHOD**
J. P. Lasalle Repr. from "Stability Problems of Solutions of Differential Equations" Gubbio, Edizioni "Oderisi", 1966 refs
(Contracts NASB-11264; DA-31-124-ARO(D)-270; Grants NGR-40-002-015; AF-AFOSR-693-65)
(NASA-CR-81060; AROD-5145-6; AD-636709) CFSTI: HC $1.00/MF $0.50 CSCL 12A

A fundamental theorem of stability is presented which is based on a broad definition of a Liapunov function, and which makes use of the invariance property of limit sets of solutions of autonomous differential equations. A simple example illustrates how this theorem goes beyond the classical theory of Liapunov, and shows how the qualitative behavior of large systems may be studied. An example is also included to show how instability criteria may be obtained from this same fundamental theorem. An analogous theorem for nonautonomous systems is given, and types of nonautonomous systems are considered in which the limit sets of their solutions permits precise information to be obtained on their asymptotic behavior by using Liapunov functions. M.G.J.

N67-15018# McGill Univ., Montreal (Quebec). Pennsylvania State Univ., University Park.
**IDENTIFIABILITY OF COUNTABLE MIXTURE OF DISCRETE DISTRIBUTION**
Ganapati P. Patil and Sheela Bildikar Wright-Patterson AFB, Ohio, ARL, Jul. 1966 57 p refs Prepared Jointly with Pa. State Univ.
(Contract AF 33(657)-11559; AF 33(615)-2763)
(ARL-66-0146; AD-640983) CFSTI: HC $3.00/MF $0.50

The subject of the mixtures of probability distributions has aroused a fresh interest in the fields of Probability and Statistics. The present report attempts to solve by using the methods of infinite matrices some of the problems of the identifiability of countable mixtures of discrete probability distributions. While most of the results discussed are believed to be new, a few of them can be shown to be immediate consequences of a powerful result due to Teicher obtained by using a different approach. Author (TAB)

N67-15028# Harvard Univ., Cambridge, Mass. Cruft Lab.
**NUMERICAL OPERATIONS ON RANDOM FUNCTIONS**
Willie C. Kellogg Apr. 1966 106 p refs
(Contract Nonr-1866(16))
(TR-496; AD-639300) CFSTI: HC $4.00/MF $0.75

The work investigates the problem of obtaining a sampled-data representation of a random function, and operating on this representation to obtain approximate reconstruction of the random function or the result of performing a linear operation on it. The author considers cases in which the input is available to the presampling filter only for a finite time, and only a finite number of samples are available for reconstruction. He describes a set of computer programs in which the optimum filters are designed, and the associated mean squared errors evaluated, by time-domain techniques. These programs compute the effects of both sampling errors and quantization errors. He includes quantitative comparisons of PCM system performance with Shannon's rate-distortion function. Author (TAB)

N67-15049# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
**ON THE REPRESENTATION OF CONTINUOUS FUNCTIONS OF TWO VARIABLES WITH THE AID OF CONTINUOUS FUNCTIONS OF ONE VARIABLE**
L. A. Bassalygo 17 Aug. 1966 11 p refs Transl. into ENGLISH from Vestn. Mosk. Univ., Ser. Mat. (Moscow), no. 1, 1966 p 58–63
(Contract NOw-62-0604-c)
(TG-230-T491; TT-66-62385; AD-639910) CFSTI: HC $1.00/MF $0.50

Translation of Russian research: on the representation of continuous functions of two variables with the aid of continuous functions of one variable. TAB

N67-15066# New York Univ., N. Y. Courant Inst. of Mathematical Sciences.
**ABEL'S EQUATION AND THE CAUCHY INTEGRAL EQUATION OF THE SECOND KIND**
Arthur S. Peters Oct. 1966 28 p refs
(Contract Nonr-285(55))
(IMM-NYU-352; AD-641368) CFSTI: HC $2.00/MF $0.50

The report shows that a Cauchy singular integral equation of the second kind can be solved by reducing it to Abel's integral equation. The reduction yields a new formula for the solution of the Cauchy equation. Author (TAB)

N67-15079# California Univ., Berkeley. Operations Research Center.
**DETERMINATION OF CLASS PROPERTIES OF A FINITE MARKOV CHAIN**
Lawrence D. Bodin Sep. 1966 24 p refs
(Contract Nonr-3656(18))
(ORC-66-22; AD-640489) CFSTI: HC $1.00/MF $0.50

A basic problem in studying Markov Chains is the determination of the class properties in each communicating class. In this paper, two algorithms for determining class properties are presented - the first algorithm finds all the class properties while the second algorithm merely finds the set of communicating classes and their classification. Extensions of these algorithms to other problems are noted and the computational efficiency of these algorithms is described. Author (TAB)

N67-15084# RAND Corp., Santa Monica, Calif.
**A GEOMETRIC DERIVATION OF TRANSVERSALITY AND CORNER CONDITIONS OF THE CALCULUS OF VARIATIONS VIA DYNAMIC PROGRAMMING**

S. E. Dreyfus Oct. 1966 19 p refs
(Contract AF 49(638)-1700; Proj. RAND)
(RM-5093-PR; AD-642405) CFSTI: HC $3.00/MF $0.65

The report shows how certain well-known geometric facts concerning the gradient of a continuously differentiable function can be used, in conjunction with dynamic programming, to deduce transversality and corner conditions of the calculus of variations. The reader is assumed to be familiar with algebraic and geometric aspects of optimal control theory. Author (TAB)

N67-15102# RAND Corp., Santa Monica, Calif.
**RECONSTRUCTING TRIANGLES FROM THICKNESS FUNCTIONS**
T. A. Brown Nov. 1966 13 p ref
(Contract AF 49(638)-1700; Proj. RAND)
(RM-5199-PR; AD-642367) CFSTI: HC $3.00/MF $0.65

The memorandum gives a complete treatment of the problem of reconstructing a traiangle from its X and Y-thickness functions. Author (TAB)

N67-15149*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**ANALYTIC LINEAR SYSTEMS OF DIFFERENTIAL EQUATIONS IN IMPLICIT FORM**
Richard J. Hanson 1 Dec. 1966 13 p refs
(Contract NAS7-100)
(NASA-CR-81078; JPL-TR-32-1041) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A local theory is developed for the system $B(z)dy/dz = A(z)y + f(z)$(1) for square holomorphic matrices A and B and a holomorphic vector f with the assumption that det $B(z) = 0$. Necessary and sufficient conditions for the existence of a solution to (1) and an algorithm for calculating this solution (provided it exists) are given. Author

N67-15298# California Univ., Berkeley. Dept. of Mathematics.
**A QUASI-GRADIENT METHOD IN CONVEX PROGRAMMING**
H. J. Bremermann and H. DeGrasse Jun. 1966 38 p refs
(Contract Nonr-222(85))
(AD-640264) CFSTI: HC $2.00/MF $0.50

The probelm of combining gradient methods and evolution algorithm methods is considered, and seven programs are discussed. Tables summarize the experiments, which were run on an IBM 7094 computer with the program written in Fortran IV. It is concluded that the program which computes quasigradients from first significant improvements is the most efficient. It is also noted that the problem of minimizing a function subject to constraints is equivalent to minimizing a discontinuous function: the constraint set can be eliminated by redefining the function on the constraint set as $+\infty$—or a suitably large constant. The buckshot method was found to handle constrained (convex programming) problems very successfully, and may be useful for optimization of discontinuous functions in general. M.G.J.

N67-15298*# Texas A&M Univ., College Station.
**A THIRD-ORDER ITERATIVE FACTORIZATION TECHNIQUE FOR POLYNOMIALS**
H. A. Luther and J. P. Mc Anally [1966] 10 p refs
(Grant NGR-44-001-024)
(NASA-CR-81148) CFSTI: HC $3.00/MF $0.65 CSCL 12A

An iterative technique is displayed whereby factors of arbitrary degree can be found for polynomials in one variable. Convergence is shown to occur always if a certain Jacobian does not vanish and if the initial approximation to a factor is near enough to an actual factor. The process is of third order and uses the second-order partial derivatives of certain associated polynomials. Because of the special nature of these associated polynomials and the technique developed, the computation time of a single iterative step is not excessive. Author

# 20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N67-14389# Joint Publications Research Service, Washington, D. C.
**METEOROLOGY AND HYDROLOGY, NUMBER 10, 1966**
12 Dec. 1966 112 p refs Transl. into ENGLISH from Meteorol. i Gidrol. (Moscow), no. 10, Oct. 1966 p 3-62
(JPRS-39061; TT-66-35484) CFSTI: $4.00

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13. WATER PROPERTIES OF SOILS AND MOVEMENT OF SOIL MOISTURE HYDROMETEOROLOGICAL PUBLISHING HOUSE LENINGRAD, 1965 L. A. Razumova p 80-85

N67-14390# Joint Publications Research Service, Washington, D. C.
**ON THE USE OF AVERAGING IN CLIMATOLOGICAL RESEARCH**
M. I. Budyko and O. A. Drozdov *In its* Meteorol. and Hydrol., No. 10, 1966 12 Dec. 1966 p 1-5 (See N67-14389 05-20)
CFSTI: $4.00

The problem of selecting expedient averaging periods for the study of the effect of climate on processes of varying duration was examined. It is noted that the expedient length of the averaging period can differ greatly for various elements of the climate, season, observation place, and processing methods, depending on the purpose of the investigation. On the whole, the expedient length of the averaging period in a climatological study is determined by the possibility of determining geographic regularities of the examined climate element with an accuracy sufficient for the given study. A.G.O.

**N67-14391#** Joint Publications Research Service, Washington, D. C.

**VERTICAL CURRENTS INSIDE THE CUMULONIMBUS**

S. M. Shmeter and V. I. Silayeva *In its* Meteorol. and Hydrol., No. 10, 1966 12 Dec. 1966 p 6–14 refs (See N67-14389 05-20) CFSTI: $4.00

Results of a study of mesoscale and turbulent vertical currents inside the peak of the cumulonimbus are presented. The flying laboratory TU-104B equipped with special physical apparatus was used in making 698 series of measurements at flights between 7 and 11 km. In computing the vertical velocities of the air, consideration was given to overloads of the airplane and its displacement in space. C.T.C.

**N67-14392#** Joint Publications Research Service, Washington, D. C.

**HEAT CONDITIONS OF THE SOVIET ARCTIC REGION WITH THE BASIC FORMS OF ATMOSPHERIC CIRCULATION**

A. A. Girs *In its* Meteorol. and Hydrol., No. 10, 1966 12 Dec. 1966 p 22–30 refs (See N67-14389 05-20) CFSTI: $4.00

The presence of essential total radiation changes and certain other heat balance components is shown in the Arctic region at the time when basic forms of circulation change in the Northern Hemisphere. Possible explanations are given for these changes on the basis of estimating the synoptic specific features of the atmospheric changes and the nature of the atmosphere and hydrosphere. The part played by general processes of atmospheric circulation of the Northern Hemisphere in the formation of the radiation and heat conditions of the Arctic region is examined, and the specific features of heat balance formation of the Arctic region in processes of meridional form are also considered. A.G.O.

**N67-14393#** Joint Publications Research Service, Washington, D. C.

**AIR FLOW AROUND AN ISOLATED OBSTACLE (NON-LINEAR PROBLEM)**

Ye. M. Pekelis *In its* Meteorol. and Hydrol., No. 10, 1966 12 Dec. 1966 p 31–42 refs (See N67-14389 05-20) CFSTI: $4.00

Descriptions and analyses are presented of results obtained in a study of nonlinear effects in airflow around an obstacle. A finite difference algorithm was used in solving the corresponding boundary value problem for the system of equations describing the flow process. Numerical experiments were performed on the basis of this algorithm, and more accurate and specific features were obtained than is possible with linear theory. C.T.C.

**N67-14394#** Joint Publications Research Service, Washington, D. C.

**EXPERIMENT OF COMPUTING THE ADVECTION OF THE VELOCITY VORTEX VERTICAL COMPONENT**

G. I. Morskoy *In its* Meteorol. and Hydrol., No. 10, 1966 12 Dec. 1966 p 43–49 refs (See N67-14389 05-20) CFSTI: $4.00

A comparison is made of the mathematical points in the solution of the nonlinear equation for the vertical component of the velocity vortex. Computations were made according to maps of geopotential (H) of a 500 mb surface and of pressure at sea level on 15 and 16 Apr. 1958. A.G.O.

**N67-14395#** Joint Publications Research Service, Washington, D. C.

**ON THE METHOD OF SNOW RESERVE MAP-MAKING**

V. M. Mishon *In its* Meteorol. and Hydrol., No. 10, 1966 12 Dec. 1966 p 63–71 refs (See N67-14389 05-20) CFSTI: $4.00

Advantages and disadvantages of methods for increasing the accuracy of snow measuring operations are discussed, with particular emphasis placed on snow measuring surveys performed in gullies and ravines. A schematic map is included of the maximum water content in the snow blanket (1943–1964) on the territory of Central Black-Earth Oblasts. A.G.O.

**N67-14396#** Joint Publications Research Service, Washington, D. C.

**SOME RESULTS OF NATURAL INVESTIGATIONS OF METALLIZED THERMISTORS**

M. B. Fridzon *In its* Meteorol. and Hydrol., No. 10, 1966 12 Dec. 1966 p 75–79 refs (See N67-14389 05-20) CFSTI: $4.00

Temperature measurements in the free atmosphere are compared for thermistors with antiradiation coatings of silver, aluminum, and chromium. It is reported that the application of a silver coating to thermistors in combination with raising them two meters above the probe body on a thin silverplated frame, eliminates completely the radiation correction used up to the altitude of 25–26km. Application of an aluminum coating decreases the radiation correction introduced by 80%. A.G.O.

**N67-14709#** White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

**THE WIND REGIME IN THE FIRST 62 METERS OF THE ATMOSPHERE**

Frank V. Hansen and Virgil D. Lang Jun. 1966 81 p refs (ECOM-5058; AD-639959) CFSTI: HC $3.00/MF $0.75

Wind regime data in the form of wind roses and frequency of occurrence for nine tower levels by the month and diurnal classification are presented. Results indicate that terrain features in the vicinity of the white sands meteorological research tower exhibit a modifying effect on the diurnal and seasonal wind regime. It was also found that seasonal variatons were in the form of a three season regime system rather than the expected four. Author (TAB)

**N67-14744#** White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

**THE DESIRABILITY OF USING A FAST SAMPLING RATE FOR COMPUTING WIND VELOCITY FROM PILOT-BALLOON DATA**

Henry Rachele and Louis D. Duncan Jul. 1966 31 p refs (ECOM-5066; AD-640157) CFSTI: HC $2.00/MF $0.50

Advantages of using a fast sampling rate for providing raw data for computing wind velocities from pilot-balloon observations are developed. Two independent approaches showed that (for a given sampling rate) the errors in the mean wind computed through a layer tend to be smaller the larger the layer. However, it is also shown that for a given layer (except for very thin layers), frequent observations through the layer will provide better wind estimates. In addition, graphs are presented which give estimates of relative wind errors as a function of sampling rate and true mean wind speed. Author (TAB)

N67-14948# Weather Squadron (29th), Duluth, Minn. Detachment 9.
**THETA PRIME CHART**
Norman G. Wiley 31 May 1966 14 p
(Rept.-29660001; AD-641988) CFSTI: HC $1.00/MF $0.50

A practical approach to the utilization of a Theta Prime Chart as a local forecasting tool. It includes a description of how to obtain and plot the data; recommends an analysis procedure; explains the meaning of a variety of possible features of the analysis and presents a number of Empirical Rules. Author (TAB)

N67-14965# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
**UPPER WIND CORRELATIONS IN THE CENTRAL ROCKY MOUNTAINS**
Roy L. Lamberth and Manuel Armendariz Jun. 1966 50 p refs
(ECOM-5061; AD-641668) CFSTI: HC $2.00/MF $0.50

Vector correlation coefficients of winds from 3 through 24 kilometers mean sea level at Grand Junction, Colorado; Salt Lake City, Utah; Ely, Nevada; and Lander, Wyoming; and between Grand Junction and these stations are presented by season in tabular form. Both synchronous and lagged values are included for interlevel and intralevel relationships. A simple technique for using the correlations as a forecast tool, including the necessary constants, is presented. By simple linear regression it is shown that wind predictions for Grand Junction may be used for Green River, Utah, with accuracy adequate for scheduling missile launchings. Author (TAB)

N67-15033# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
**EVALUATION OF AN ECONOMICAL INSTRUMENT SHELTER FOR MICROCLIMATOLOGICAL STUDIES**
T. C. Vogel and P. L. Johnson May 1966 7 p ref
(CRREL-SR-84; AD-640384) CFSTI: HC $1.00/MF $0.50

A number of inexpensive, lightweight instrument shelters capable of screening meteorological instruments in the field were required for an ecological research project in northern Alaska. Such a shelter had to be inexpensive, collapsible for shipment, easily assembled in the field, capable of housing recording instruments as large as a Friez hygrothermograph, and comparable to a standard U. S. Weather Bureau shelter or Stevenson screen in its ambinet thermal characteristics. These criteria were met by a design which was fabricated and successfully employed at six sites at Barrow, Alaska, during July and August 1964. Author (TAB)

N67-15081# McGill Univ., Montreal (Quebec). Arctic Meteorology Research Group.
**HARMONIC REPRESENTATION APPLIED TO LARGE SCALE ATMOSPHERIC WAVES**
Philip Merilees Sep. 1966 189 p refs *Its* Publ. Meteorol. No. 83
(Contract AF 19(628)-4955)
(AFCRL-66-708; SR-3; AD-642154) CFSTI: HC $3.00/MF $0.65

Spectral analysis (primarily in terms of spherical harmonics) is applied to the atmospheric dynamical equations in general, to truncated barotropic systems in particular and, in addition, to the global geopotential height field of the 500 mb surface for September 1957. The complete set of equations governing adiabatic frictionless flow transform into the spectral domain, and are energetically consistent under practically any truncation procedure. Analysis of truncated barotropic systems leads to a reinterpretation of barotropic instability in terms of the frequency of momentum transport. There is no evidence that the fluctuations of spherical harmonic waves at 500 mb are global in character, but the lack of data in the Southern Hemisphere limits the validity of this conclusion. Hemispheric analysis of the geopotential height field at 500 mb for the Northern Hemisphere indicates that the planetary waves are composed of a quasi-stationary component and a rapidly retrogressive component whose phase speeds are a large fraction of the theoretical Rossby-Haurwitz phase speeds. Author (TAB)

N67-15158*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**PRELIMINARY RESULTS FROM NIMBUS II**
W. Nordberg, A. W. Mc Culloch, L. L. Foshee, and W. R. Bandeen Aug. 1966 42 p refs
(NASA-TM-X-55638) CFSTI: HC $3.00/MF $0.65 CSCL 04B

Preliminary analysis indicates Nimbus II to be a versatile meteorological observatory. Radiation observations can be made in seven regions of the visible and infrared spectra, and images of meteorological phenomena and surface features can be obtained on four different size scales. Correlations among the pictorially displayed images of meteorological systems in the water vapor, carbon dioxide, and window channels permit better insight into circulation associated with synoptic scale systems than does mere imaging of clouds in the visible or infrared spectra. Stage of development of storms and frontal systems can be assessed more readily, and cloud systems of the intertropical convergence zone can be traced around the globe every 12 hr. Migration of warm air pockets around the South Pole during the Antarctic winter are indicated. Both high resolution and medium resolution infrared radiometer experiments are reported; and water vapor patterns and cloud pictures, atmospheric temperatures, and quantitative radiation measurements are given. M.W.R.

N67-15317# Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.
**SOME CHARACTERISTICS OF THE THREE-DIMENSIONAL STRUCTURE OF SANTA ANA WINDS**
Michael A. Fosberg, Clyde A. O'Dell, and Mark J. Schroeder 1966 44 p refs
(Contract OCD-PS-65-27)
(PSW-30; AD-640216) CFSTI: HC $2.00/MF $0.50

The three-dimensional structure of the Santa Ana was investigated in two case studies. Incorporated into a descriptive model of the Santa Ana were: (a) a bispectral gravity wave flow with a lee trough, produced by conservation of potential vorticity having a wave length of the order of 300 km, and short waves 6 to 10 km. long; (b) intensity of the foehn related to the Montgomery stream function on an isentropic surface in the upper portion of the planetary boundary layer; and (c) foehn islands and foehn surfacing related to the long and short waves, respectively. Author (TAB)

N67-15331# Naval Research Lab., Washington, D. C.
**WATER VAPOR OBSERVATIONS AT LOW, MIDDLE, AND HIGH LATITUDES DURING 1964 AND 1965 Final Report**
Henry J. Mastenbrook 13 Sep. 1966 207 p refs
(Grant NSF GP-876)
(NRL-6447; AD-641577) CFSTI: HC $8.00/MF $1.25

The vertical distribution of water vapor to stratospheric levels has been measured over Washington, D. C.; Trinidad, West Indies; and Thule, Greenland, during 1964 and 1965, the period of the International Years of the Quiet Sun. The data for fifty-one soundings are presented individually in graphs and tables. Author (TAB)

# 21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N67-14741# Naval Research Lab., Washington, D. C.
**AIRCRAFT LANDING APPROACH PATHS WITH THE RAINBOW OPTICAL LANDING SYSTEM**
Barbour Lee Perry and Patricia A. Griffin 27 Jun. 1966 59 p refs
(NRL-6380; AD-639643) CFSTI: HC$3.00/MF$0.75

The Rainbow Optical Landing System is designed to present color-sequence-encoded sink-rate-error information to a pilot landing aboard a carrier. As the name implies, the Rainbow system utilizes a tricolor, dynamic light beam projected into the sky from a point near the landing spot. The approach path and associated sink rate of an aircraft whose pilot is flying the Rainbow system have been determined and plotted for several values of different system parameters. On the basis of these plots, optimal values of beam-pattern parameters can be selected. In addition, the effects on overall system performance of aircraft approach parameters such as initial error, initial range, and rate of approach to the carrier, can be displayed in the form of graphs and numerical tables. This analytical methodology can be readily applied to other systems which display higher-derivative-command signals. Author (TAB)

N67-14788*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**GUIDANCE-AND-CONTROL SYSTEM STERILIZATION**
John C. Nicklas, William E. Bachman, Edgar S. Davis, Edgar F. Koch, and Roy J. Mankovitz In NASA. Washington Spacecraft Sterilization Technol. 1966 p 379-392 ref (See N67-14761 05-05) GPO: HC$2.25; CFSTI: HC$2.50

The sterilization of guidance-and-control systems is treated from the standpoint of both the components and systems. In the components effort, the status of development work in optical sensors, inertial devices, and actuators is discussed. The work in optical sensors is directed toward the development and investigation of the problems associated with photoconductive detectors and an image dissector. A gas-bearing gyro, an accelerometer, and an electrostatic gyro are included in the present inertial sensor development areas. Attempts to sterilize inertial components of the early Ranger spacecraft are also discussed. The actuator investigations concern servomotors, a direct-current torquing device, and a high-ratio small-volume gear train. Differential expansion and dimensional stability are the major study areas for these devices. The systems effort is directed toward establishing the need for the specific components required and the problems anticipated in the sterilization of entire systems for future missions. In some cases new system mechanizations are proposed as a solution to the sterilization problem. Finally, the major problem areas foreseen are mentioned. Author

N67-14963# Bell Helicopter Co., Fort Worth, Tex.
**A HELICOPTER FLIGHT EVALUATION OF A HEAD-UP DISPLAY**
James G. Curtin and John H. Emery Feb. 1966 66 p refs
(Nonr-4429(00))
(D228-420-010; AD-640598) CFSTI: HC$3.00/MF$0.75

The purpose of the study was to determine the feasibility of using the Computing Devices of Canada, Ltd. Spectocom Head-Up Display in a helicopter for instrument landing approaches. The first phase examined IFR landing approach performance with the display in the fixed-wing design configuration. No other flight displays were presented. The second phase examined the same maneuver with the display augmented with heading information. Test conditions included: full VFR, simulated intermittent IFR and simulated full IFR. The test vehicle was an Army OH-13K Bell helicopter. Six rated and highly experienced helicopter pilots participated as test subjects. Results indicated that, when the display was used in the configuration designed for fixed wing, lateral flight path control was poor and IFR landing approaches were unacceptable. When heading information was added satisfactory approaches were made to a break-out altitude of 100 feet. Author (TAB)

N67-14994# Naval Research Lab., Washington, D. C.
**DIFFERENTIAL OMEGA Interim Report**
J. W. Brogden and K. O. L. Luken 8 Aug. 1966 24 p
(NRL-MR-1716; AD-640013) CFSTI: HC$1.00/MF$0.50

The differential Omega concept makes use of a control monitor to determine the difference between the received phase of the Omega signals and the computed or charted value. The difference noted by the control station, which is at a known location, is transmitted as a correction factor to the users in the field. This correction factor could also be based on a correction to the published sky-wave correction tables. Fixed monitors were established at this Laboratory in Washington, at the Chesapeake Bay Division at Chesapeake Beach, Maryland, and at the U. S. Coast Guard Electronic Engineering Center at Wildwood, New Jersey. The report is based on the data obtained at the start of the study. The results show that accuracies of one-half mile or better over a 24-hour period can be obtained at distances up to 100 miles from the control station. Author (TAB)

N67-15335# Naval Research Lab., Washington, D. C.
**THE USE OF DISPLACEMENT, FLASH, AND DEPTH-OF-FLASH CODED DISPLAYS FOR PROVIDING CONTROL SYSTEM INFORMATION Interim Report**
P. N. Ziegler, R. E. Reilly, and R. Chernikoff 6 Jul. 1966 10 p refs
(NRL-6412; AD-639644) CFSTI: HC$1.00/MF$0.50

Two experiments were performed to investigate the use of brightness-coding and flash-coding techniques for presenting information usually provided by displacement displays. The first experiment compared a conventional displacement display with this same display incorporating flash coding, using one of two frequencies to indicate high or low error direction. The results of the study showed that at longer viewing ranges, at which the displacement cannot be discriminated, tracking performance was enhanced by the addition of flash coding to the displacement display. The second experiment, using a point source of light, compared flash coding (of error direction) with combined flash and brightness coding(of error direction plus magnitude). This latter display, termed depth of flash, was found to be superior after a relatively short learning period. The findings indicate that the depth-of-flash technique may be a fruitful approach in the development of an effective landing aid. Author (TAB)

# 22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

**N67-14617#** Iowa State Univ. of Science and Technology, Ames. Ames Lab.
**REACTOR UTILIZATION Annual Summary Report**
F. H. Spedding, W. H. McCorkle, J. S. Crudele, G. M. Day, B. W. Link et al *In its* Chem., Eng., Met., Phys. and Reactor Div. Jul. 1966 38 p refs (See N67-14612 05-34) CFSTI: HC $7.94/MF $2.25

Operational characteristics of an experimental research reactor are presented. Modifications, such as the pneumatic rabbit delivery systems extensions and high efficiency filter system, are mentioned. Experimental irradiations are reported and causes of reactivity change are considered. In addition, fuel and control rod removal and reloading of the research reactor are discussed. Several minor experiments in support of the reactor are described. S.P.

**N67-14685#** General Electric Co., San Jose, Calif.
**EXPERIMENTAL STUDIES OF PLUTONIUM AND FISSION PRODUCE REDISTRIBUTION IN FAST REACTOR FUELS**
T. A. Lauritzen, P. E. Novak, and J. H. Davies Mar. 1966 17 p refs
(Contract AT(04-3)-189)
(GEAP-4466) CFSTI: HC $1.00/MF $0.50

An attempt is made to clarify the behavior of mixed-oxide fuels with regard to Pu and fission product redistribution and to assess both their magnitude and consequences on the operation of fast reactor systems. The Pu and fission product redistribution in mixed-oxide fuel operated above the melting point reduces the Doppler shutdown reactivity by 4 percent or less. Author (NSA)

**N67-14686#** Atomic Energy Commission, Chicago, Ill. Reactor Engineering Div.
**AN EVALUATION OF THE ATOMICS INTERNATIONAL 1000 MWE FAST BREEDER REACTOR**
C. Fies, ed. Jul. 1966 58 p refs
(COO-285) CFSTI: HC $3.00/MF $0.75

A conceptual design of a 1000 Mw(e) Liquid Metal Fast Breeder Reactor is compared to four similar conceptual designs evaluated in COO-279 (NSA 19: 10532). The similarities and differences between the Atomics International (AI) design and the previous four designs are discussed and certain nuclear properties of the AI study are reviewed. The result of a recalculation of some of the nuclear properties considered in COO-279 are given. NSA

**N67-14727#** Naval Research Lab., Washington, D. C. Reactor Materials Branch.
**IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS Quarterly Progress Report, 1 May–31 Jul. 1966**
Lendell E. Steele, J. Russell Hawthorne, Robert A. Gray, Jr., Eugene P. Klier, Charles Z. Serpan, Jr. et al 15 Aug. 1966 39 p refs
(Contract AT(49-5)-2110)
(NRL-MEMO-1719; AD-639835) CFSTI: HC $2.00/MF $0.50

The research program of the NRL Metallurgy Division, Reactor Materials Branch, is devoted to the determination of the effects of nuclear radiation upon the properties of structural materials. The overall program is sponsored by the Office of Naval Research, the Naval Ship Systems Command, the U. S. Atomic Energy Commission, and the Army Nuclear Power Program. Since research findings which apply to the objectives of one sponsoring agency are also of interest to the others, the overall program progress is reported herein. This report includes the following: (1) results of a comparative irradiation of weld heat affected zone and base metal specimens of HY-80 steel, (2) preliminary data on the notch ductility characteristics of irradiated maraging and nickel-cobalt steels, (3) tensile properties of selected steels having potential for nuclear structural application, (4) irradiation damage surveillance results from specimens exposed near the Yankee reactor pressure vessel, and (5) description of the recently completed metallographic cell of the NRL High Level Radiation Laboratory. Author (TAB)

**N67-14821#** Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
**LARGE SCALE PRODUCTION AND APPLICATIONS OF RADIOISOTOPES**
May 1966 286 p refs Proc. of the Am. Nucl. Soc. Natl. Topical Meeting, Augusta, Ga., 21–23 Mar. 1966
(Contract AT(07-2)-1)
(DP-1066, Vol. II) CFSTI: $7.00

Conference papers on large-scale isotope production (reactors and chemical processing) and radioisotope applications are presented. For individual titles see N67-14822–N67-14844.

**N67-14822#** Battelle-Northwest, Richland, Wash.
**PRODUCTION AND INDIFFERENCE PRICING OF TRANSURANIUM ISOTOPES**
D. E. Deonigi and E. A. Eschbach *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 37 p refs (See N67-14821 05-22) CFSTI: $7.00
(Contract AT(45-1)-1830)

This paper indicates the computed rates at which Np-237, Pu-238, Am-241, Am-243, Cm-242 and Cm-244 are incidentally produced by simulated power reactors. Also shown is the extent to which some power reactor fueling methods can be altered to increase the production and purity of Pu-238 and Cm-244. An explanation of the indifference price concept is introduced in order to assess the effect of various Pu-238 and Cm-244 credits on the equitable price of the preceding, or target, isotopes. Other calculations in this paper show how various credits for transuranium isotopes would affect fuel-cycle costs both for normal fueling methods and for some altered fueling methods in power reactors. Author

**N67-14823#** Douglas United Nuclear, Inc., Richland, Wash.
**A MODEL TO OPTIMIZE Pu-238 PRODUCTION BY FUEL RECYCLE**
R. Nilson and C. W. Showalter (AEC, Washington, D. C.) *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 14 p refs (See N67-14821 05-22) CFSTI: $7.00
(Contract AT(45-1)-1857)

The mathematical model encompasses both the production and economic aspects of increasing $^{237}$Np production by recycling fuel. The incremental cost factors which are considered are cost of blend-up of the reactor tails to the initial fuel enrichment, cost to the reactor for the increased enrichment because of the $^{236}$U introduced, and the difference in the feed material chain costs between recycling and not recycling, including interest charges on the fuel during a storage period while it is waiting return to the reactor. NSA

**N67-14824#** Douglas United Nuclear, Inc., Richland, Wash.
**OPTIMIZING Pu-238 PRODUCTION FROM IRRADIATION OF Np-237**
R. H. Meichle and G. F. Owsley *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 14 p refs (See N67-14821 05-22) CFSTI: $7.00
(Contract AT(45-1)-1857)

The parameters involved in the production of $^{238}$Pu from the irradiation of $^{237}$Np in thermal reactors are discussed. Four independent factors strongly affect the production rate, conversion

efficiency, and quality of $^{238}Pu$ from the irradiation of $^{237}Np$. These are the neutron flux level, the neutron spectrum, the in-reactor residence for one cycle, and the out-of-reactor holdup time of the unconverted $^{237}Np$ prior to recharging in the reactor. These parameters are discussed. NSA

**N67-14825#** Commissariat a l'Energie Atomique, Saclay (France).
**COBALT-60 PRODUCTION IN GRAPHITE GAS COOLED REACTORS**
R. Henry and A. Meyer-Heine *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 11 p refs (See N67-14821 05-22)

The possibilities of cobalt absorber irradiations are studied from the neutronic and technological point of view. Consideration is given to the technical implications of cobalt production in a graphite gas cooled reactor and the antireactivity of cobalt absorber located in a channel. Determination of the number of cobalt elements to be charged is discussed, and a cost estimate is given in tabular form. It is noted that, for economical reasons, the main objective remains the use of depleted fuel. A.G.O.

**N67-14826#** Battelle-Northwest, Richland, Wash.
**MANAGEMENT OF AMERICIUM IN POWER REACTOR FUELS TO OPTIMIZE PRODUCTION OF ALPHA-EMITTING ISOTOPES**
L. W. Lang *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 13 p refs (See N67-14821 05-22) CFSTI: $7.00
(Contract AT(45-1)-1830)

The choice of a reactor and the length of irradiation time are unique production determinants in isotope yield from the mixed americium isotopes. Machine calculations were performed for two neutron spectra (those typical of pressurized water reactors (PWR) and heavy water reactors (HWR)), neutron flux ($5\times10^{13}$, $2\times10^{14}$, and $1\times10^{15}$ nvt) and the period of irradiation (one to 24 months) to determine isotope yields from a specific amount of mixed americium isotope. The calculations indicate that the harder flux spectra typical of pressurized water reactors with short irradiation periods results in a greater production of $\alpha$-emitting isotopes compared to that produced in a softer neutron spectrum for equivalent or long irradiation times. The data are summarized. NSA

**N67-14827#** European Atomic Energy Community, Dessel (Belgium).
**PRODUCTION OF COBALT-60 IN THE BR2 REACTOR, BELGIUM**
W. Hebel *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 9 p (See N67-14821 05-22) CFSTI: $7.00

Descriptions are given of the reactor and the cobalt samples which are irradiated in the reactor in order to produce cobalt 60. The cobalt weight which can be charged into the irradiation channels is considered and core reactivity loss and activity production are discussed. A.G.O.

**N67-14828#** Battelle-Northwest, Richland, Wash.
**FISSION PRODUCT RECOVERY RESEARCH AT BATTELLE-NORTHWEST**
R. L. Moore *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 8 p refs (See N67-14821 05-22) CFSTI: $7.00

The major recent developments in fission produce recovery at the Pacific Northwest Laboratory (formerly Hanford Laboratories) are described. Process optimization studied for the compact band ion exchange separation of individual light rare earth elements, using DTPA, EDTA, or HEDTA as eluting agents. Equipment for purifying kilogram quantities of promethium has been installed recently, and was applied to the preparation of 62,500 Curies of very high-purity promethium. A process for recovery of fission product rhodium has been developed, and used for the purification of one gram of rhodium. Earlier work at Hanford Laboratories is briefly summarized by specific fission product, with respect to scientific and technical contributions, as well as the large-scale manufacturing production program which has resulted from application of this new technology. Author (NSA)

**N67-14829#** Battelle-Northwest, Richland, Wash.
**CHEMICAL ANALYSIS OF SPENT POWER REACTOR FUELS**
F. P. Roberts and H. H. Van Tuyl *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 4 p refs (See N67-14821 05-22) CFSTI: $7.00
(Contract AT(07-2)-1)

The isotopic composition of Pm in typical spent power reactor fuels was evaluated. Also, the amounts of a number of fission product and heavy element isotopes were determined for the purpose and lending factual support for calculations of the value of these isotopes in spent reactor fuels. Four samples of fuel from the Yankee Reactor (a typical pressurized water reactor) and three from the Vallecitos Boiling Water Reactor were analyzed. The results showed that Pm from power reactors of the type studied will not contain intolerable amounts of $^{146}Pm$. For the worst case (Yankee), the Pm would require no more shielding than $^{238}Pu$ for many source sizes and applications. Data from the analyses of actinide elements and pertinent fission products in the fuels provide a basis for predicting the production rates of various reactor by-products. NSA

**N67-14838#** Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
**APPLICATION OF A RADIOISOTOPE HEAT SOURCE INTERIOR TO A TABULAR THERMOELECTRIC GENERATOR**
L. H. Boman *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 12 p refs (See N67-14821 05-22) CFSTI: $7.00

This paper presents the calculated initial performance of a tubular thermoelectric generator, and the limitations on an isotopic source for application within such a generator. In addition to the limitation on isotopic source requirements, several examples of space and terrestrial applications of the system are given as an indication of its potential. By inserting a cylindrical isotopic source inside of the tubular thermoelectric generator and providing a means of heat removal from the outer surface of the generator a light-weight, rugged, compact, static, power system is formed. In this design lead telluride thermoelectric material is formed into p- and n-type washers which are alternately stacked inside the generator. Author

**N67-14839#** Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
**CURIUM-244 FOR RADIOISOTOPIC HEAT SOURCES WORK AT SAVANNAH RIVER LABORATORY**
W. R. McDonell, P. K. Smith, E. F. Sturcken, J. T. Livingston, M. C. Thompson et al *In its* Large Scale Production and Appl. of Radioisotopes May 1966 13 p refs (See N67-14821 05-22) CFSTI: $7.00

Preliminary studies of the curium-oxygen system have demonstrated the existence of five compounds of lower oxygen content than $CmO_2$. One or two of these oxides appear to be sufficiently refractory to fuel a high-temperature heat source. Thermal and physical properties of these and other compounds of curium and their compatibility with refractory containment metals are being determined. A facility specifically designed for studying properties of small quantities of curium-244 and other alpha-emitting compounds is nearing completion, and shielded facilities for handling larger quantities are being designed. NSA

N67-14840# Union Carbide Corp., Oak Ridge, Tenn.
**HEAT TRANSFER IN THE DESIGN OF LARGE RADIOISOTOPE HEAT SOURCES**
J. C. Posey and R. E. Mc Henry *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 6 p refs (See N67-14821 05-22) CFSTI: $7.00

Methods are outlined by which temperatures in heat sources with simple geometric shapes can be calculated, and design techniques by which the temperatures can be held to reasonable levels are suggested. NSA

N67-14841# United Kingdom Atomic Energy Authority, Harwell (England).
**RADIOISOTOPE POWERED GENERATOR DEVELOPMENT IN THE UNITED KINGDOM**
G. E. Hare *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1961 8 p (See N67-14821 05-22) CFSTI: $7.00

The development of the first $Sr^{90}$ powered units, RIPPLE I and RIPPLE II, is outlined with several diagrams and photographs of these generators being included. Consideration is given to the factors affecting both the technical and economic aspects of radio isotope powered thermoelectric generators with emphasis on the developments involved in the buildup of industrial participation. A.G.O.

N67-14842# Conservatome Industries Co., Lyon (France).
**CONSTRUCTION AND FIRST RESULTS OF OPERATION OF "IRMA 400/1". FIRST MOBILE IRRADIATOR WITH CESIUM-137**
*In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 18 p (See N67-14821 05-22) CFSTI: $7.00

A mobile irradiator was designed and built with the purpose of promoting various industrial applications of gamma radiation in the fields of medical sterilization, radiochemistry, and food industry. This facility, which utilizes a cesium 137 source of 173,000 curies, is described, and the first results of operation are discussed. Consideration is given to facility operation, the radioactive source, safety factors, and irradiator price. A.G.O.

N67-14843# De Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
**LARGE SCALE COBALT-60 HEAT SOURCES**
F. D. King and C. L. Angerman *In its* Large Scale Production and Appl. of Radioisotopes May 1966 18 p refs (See N67-14821 05-22) CFSTI: $7.00

The production and handling of $^{60}Co$ at the Savannah River Laboratory is discussed, and the development and design requirements for practical $^{60}Co$ heat sources are summarized. NSA

N67-14844# North Carolina State Coll., Raleigh. Nuclear Reactor Project.
**LARGE SCALE APPLICATIONS OF RADIOISOTOPES FOR THERMAL ENERGY PRODUCTION**
M. A. Walt *In* Du Pont de Nemours (E. I.) and Co. Large Scale Production and Appl. of Radioisotopes May 1966 7 p refs (See N67-14821 05-22) CFSTI: $7.00

Projects involving the application of radioisotopic power for remote area heating, saline water conversion, and water recovery systems are discussed. A shielded core direct air cycle design concept is investigated with specifications which called for a thermal output of 50,000 Btu/hr, an operation lifetime of 10 years, and portability in the sense that it could be easily airlifted and installed without radiological hazard in remote locations. A.G.O.

N67-14886*# Lockheed Missiles and Space Co., Sunnyvale, Calif. Aerospace Sciences Lab.
**EMISSIVITY COATINGS FOR LOW-TEMPERATURE SPACE RADIATORS Quarterly Progress Report, Period Ending 31 Dec. 1965**
F. J. Smith and J. G. Grammer 31 Dec. 1965 28 p refs
(Contract NAS3-7630)
(NASA-CR-72059: QPR-2) CFSTI: HC $3.00/MF $0.75 CSCL 18F

Investigations of candidate coatings for low temperature spacecraft radiators having long operational lifetimes are presented. Activities focused on a literature survey to provide up-to-date information on emissivity coatings. An exposure apparatus was checked, and initial calibration data were obtained. All test specimens were received and pretest optical property measurements were performed. Modification of the xenon source optics is described, and results of the initial operation of the exposure apparatus are given. S.P.

N67-14969# Naval Research Lab., Washington, D. C.
**DAMAGING NEUTRON EXPOSURE CRITERIA FOR EVALUATING THE EMBRITTLEMENT OF REACTOR PRESSURE VESSEL STEELS IN DIFFERENT NEUTRON SPECTRA Interim Report**
Charles Z. Serpan, Jr. and Landell E. Steele 28 Jul. 1966 31 p refs
(NRL-6415; AD-639748) CFSTI: HC $2.00/MF $0.50

Several such exposure criteria have been evaluated through use of the results of metallurgical tests of reference steel specimens after irradiation in light and heavy water moderated reactor environments as well as in graphite moderated reactor environments. The radiation-induced transition temperature or nil-ductility transition (NDT) temperature increases of the several steels involved are presented versus n/cm2 determined by each of the following techniques: (a) assumption of a fission spectrum, extrapolation of activation data induced at a high Mev threshold to 1 Mev, and reporting exposure > 1 Mev, and (b) calculation of spectra used to determine activation cross section for exposures above energy limits of 1, 0.5, and 0.183 Mev. The differences observed by the analysis were intercompared in relation to absolute magnitude as well as in terms of engineering significance. By applying these criteria to data relating directly to a pressurized light water power reactor, benefits to the lifetime of the reactor can be realized. The results of this study to date indicate that data relating to the properties of steels irradiated in or near the core of pressurized light water moderated reactors can be confidently intercompared for engineering applications assuming a fission spectrum and accounting for neutrons of energies >1 Mev. On the other hand, calculated spectra and average cross section adjustment to an energy limit as low as >0.183 Mev must be applied to data from highly moderated reactors. Author (TAB)

N67-15038# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**MATERIAL FOR MANUFACTURING IONIZING CHAMBERS WHICH MEASURE THE DOSE OF X-RAY RADIATION**
E. F. Garapov, M. F. Lebedeva, and K. I. Shchekin 18 Apr. 1966 6 p Transl. into ENGLISH from Soviet Patent No. 169778 (Appl. No. 819447/23-26, 18 Feb. 1963) 1 p
(FTD-TT-66-1302; AD-640288) CFSTI: HC $1.00/MF $0.50

The proposed material for making ionization chambers which measure the dose of X-ray radiation, consists of 45 to 90% of polyethylene and 50 to 55% of graphite. Such a composition makes it possible to prepare chambers which possess a run with rigidity of plus or minus 10%. Author (TAB)

# 23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

**N67-14365#** Automation Industries, Inc., Boulder, Colo. Research Div.

**FOCUSED ULTRASONIC BEAMS**

J. T. Mc Elroy Sep. 1966 30 p refs

(TR-66-40)

The objective of this study is to critically measure and analyze the focal lengths and beam dimensions of commonly used focused search units. From the data, charts and graphs were compiled showing characteristics of lens radius, focal distance crystal diameter, beam diameter, and the ratio of lens radius: crystal diameter, (R/D) ratio. These charts and graphs can be used to predict focal distance for a given combination of lens radius and crystal diameter; beam diameter at the focal point for a given combination of lens radius and crystal diameter; beam diameter at any point along the focal pattern; and optimum ratio of lens radius: crystal diameter (R/D). Each search unit used in this study was investigated by profile recording for beam homogeneity. These profiles were made before focusing to insure beam symmetry. Beam diameter and beam width measurements were made using a micrometer screw to generate the transverse movement. The beam diameters and widths were measured from the 1/10th amplitude, through the peak, to the 1/10th amplitude point on the opposite side. The search units chosen for this study were 20 or more wavelengths in diameter at their respective frequencies. The lenses on all search units were cast epoxy resin, free of porosity, and cast directly on the face of the search unit. Sound velocity of the epoxy is 2.79 mm/μsec. Special care was taken to insure that the apex of the lens occurred at the exact center of the crystal. Thirty-six combinations of lens radius: crystal diameter configurations were used to compile the data. Author

**N67-14420*#** Purdue Univ., Lafayette, Ind.

**QUALITATIVE METHODS IN THE *n*-BODY PROBLEM**

Harry Pollard *In* Wis. Univ. Lectures in Appl. Math. Vol. 5: Space Math., Pt. 1 1966 p 259–291 refs (See N67-14410 05-30) CFSTI: HC $6.00/MF $1.50

Techniques and methods used in the one-, two-, three-, and many body problems are reviewed. The Lagrange–Jacobi identity and the Tauberian theorem, and their applications are described. Sundman's theorems on two-particle collisions are presented and discussed. N.E.N.

**N67-14474*#** Grenoble Univ. (France).

**MECHANICAL AND GEOMETRIC ANISOTROPY OF COHESIONLESS MEDIA [ANISTROPIE MECANIQUE ET GEOMETRIQUE DES MILIEUX PULVERULENTS]**

J. Bizez *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 223–248 refs In FRENCH; ENGLISH summary (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

To determine the geometric and mechanical anisotropy of cohesionless media, sand and glass sphere media were studied. Discrete calculations were made and suggest certain strain mechanisms found qualitatively in complex materials such as sand. A third medium was used formed by piling parallel cylinders of circular or arbitrary section. This two-dimensional medium follows better than any other material the perfect plasticity of Coulomb's law. Mechanical property studies were made of the two former media; deformations were measured in three orthogonal directions with a precision of a few microns. The experiments show that the cohesionless media (even formed with spheres) present a clear anisotropy of the mechanical properties. This study is intended to show that anisotropy of the mechanical properties is connected with a geometrical anisotropy of the structure of the arrangement. R.U.

**N67-14526*#** Bucharest Univ. (Rumania).

**THE BRAKING OF HIGH-SPEED MOVING BODIES BY EXTENSIBLE STRINGS**

N. Cristescu *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 59–78 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

When extensible strings (or cables) are used to brake high-speed moving bodies, large transverse motions accompany the longitudinal deformations. This problem is analyzed an a numerical example is given. Depending on the mechanical behavior of the string, on its initial position, strain, and motion, and depending also on the initial motion of the striking body, the moment of complete braking as well as the final position and length of the string can be computed. At every moment the maximum local strain can also be computed to predict the point of the string where breaking is likely to occur. Author

**N67-14680#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ACCUMULATION AND CONSUMPTION OF RADIATION IN A LAYER USING SEPARABLE MIRRORS**

A. M. Samson 18 Apr. 1966 8 p refs Transl. into ENGLISH from Vestsi Akad. Navuk Belarusk. SSR, Ser. Fiz.-Tekh. Navuk (Minsk), no. 3, 1964 p 129–131

(FTD-TT-65-1379; TT-66-62418; AD-640254) CFSTI: HC $1.00/MF $0.50

Translation of Russian research: accumulation and consumption of radiation in a layer using separable mirrors. TAB

**N67-14682#** Oak Ridge National Lab., Tenn. Isotopes Development Center.

**PREPARATION OF CHARGE MATERIALS FOR ORNL ELECTROMAGNETIC ISOTOPE SEPARATORS, SUPPLEMENT I**

C. W. Sheridan, H. R. Gwinn, and L. O. Love Sep. 1966 15 p refs

(Contract W-7405-ENG-26)

(ORNL-3301, Suppl. I) CFSTI: HC $1.00/MF $0.50

The preparation of those charge materials that result in either greater ion output, better isotopic purity, higher ion retention, or smoother operation in the separator is discussed. NSA

**N67-14695#** California Univ., Livermore. Lawrence Radiation Lab.

**VERY HIGH MAGNETIC FIELDS PRODUCED BY CAPACITOR-BANK DISCHARGE**

James W. Shearer 13 Apr. 1966 16 p refs Presented at the Intern. Colloq. on Intense Magnetic Fields, Grenoble, France, 12–14 Sep. 1966

(Contract W-7405-ENG-48)

(UCRL-14831; CONF-660921-1) CFSTI: HC $1.00/MF $0.50

It is calculated that transient magnetic fields in the range of 2 to 8 MG can be produced in an initial volume of ≃0.1 cc by discharging large capacitor banks into properly designed loads. The value of the peak magnetic field in a given geometry is shown to depend primarily on the voltage of the capacitor bank and the compressibility of the walls. A magnetic field of 2.1 MG was measured in an experiment for which 2.6 MG was calculated by numerical computation methods. Heating of the wires of the induction probe used to measure this field is negligible when thin enough wire is used. Pulsed X-ray radiography is used to study the geometry of the compression distribution in the metal wall surrounding the high-field volume. This compression distribution is then compared to the numerical computations. At these high fields

the metal load explodes as violently as TNT; and the experiments must be performed in a blast-proof room. However, this blast energy is small in comparison with that of typical high-explosive magnetic-field implosion experiments. Thus the high-voltage capacitor bank should be an economically useful means of producing multi-megagauss fields. Author (NSA)

N67-14701# Rand Corp., Santa Monica, Calif.
**DIFFUSE TRANSMISSION OF LIGHT FROM A CENTRAL SOURCE THROUGH AN INHOMOGENEOUS SPHERICAL SHELL WITH ISOTROPIC SCATTERING**
R. E. Bellman, H. H. Kagiwada, R. E. Kalaba, and S. Ueno Sep. 1966 18 p refs
(Contract AF 49(638)-1700; Proj. Rand)
(RM-5126-PR; AD-640301) CFSTI: HC $1.00/MF $0.50

A partial differential integral equation is derived for the angular distribution of the radiation which is diffusely transmitted through an inhomogeneous, isotropically scattering, spherical shell when there is a constant net flux of radiation normally incident on the inner surface. An equation is also derived for the strength of the diffusely reflected radiation when the shell is illuminated at each point on the outer surface by constant isotropic incident radiation. The equations obtained appear to lend themselves well to numerical solution. Astrophysically, the situation corresponds to determining the brightness of a spherical planetary nebula. As far as is known, the equations are new and exact. Author (TAB)

N67-14729 Yale Univ., New Haven, Conn. Kline Geology Lab.
**COMPRESSION OF MERCURY TO HIGH PRESSURE**
Lance Alan Davis (Ph.D. Thesis) Aug. 1966 105 p refs
(Contract Nonr-609(44))
(TR-8; AD-640172) CFSTI: HC $4.00/MF $0.75

A method for calculating volume results from high pressure acoustic data was developed which is not limited to small compressions by the assumption of a constant ratio of isothermal to adiabatic compressibility. This method thereby extends the useful range of the ultrasonic technique for determining compression data. In order to demonstrate the technique, high pressure sonic velocity experiments were performed as a function of temperature on liquid mercury. The apparatus and techniques necessary for determining the velocity of sound in the Hg and for generating and measuring high pressures were developed. A variant of the pulse-echo technique was used to determine the sonic velocity. A supported cylinder-and -piton pressure apparatus was constructed which is capable of attaining pressures of about 25kb. The Hg sample was held in a small stainless steel container which was inserted in the 1 in. bore of the pressure vessel. Pressure was determined by monitoring the resistance of a coil of Au - 2.1% Cr wire which was calibrated for pressure against a dead weight tester. The volume data obtained were analyzed to determine the functional form of the equation of state of liquid Hg. It is found that the equation of state is most appropriately written as an expansion of P either in terms of V sub zero/V or in terms of 1nV. Author (TAB)

N67-14758# Rydbeck Research Associates, Fjaras (Sweden).
**COUPLED WAVES IN MAGNETO-IONIC MEDIA, PART I**
O. E. H. Rydbeck and A. Hjalmarson Jun. 1966 124 p refs
(Contract AF 61(052)-864)
(SR-3; AFCRL-66-651, Pt. 1; AD-640237) CFSTI: HC $4.00/MF $0.75

Coupled magneto-ionic equations in total fields, for arbitrary primary wave incidence, and arbitrarily varying medium parameters, are solved in terms of first order mode amplitude equations, expressed in terms of so-called inhomogeneous or homogeneous wave numbers. For media with symmetric wave propagation properties, the first order mode amplitude equations can also be replaced by gradient coupled, second order wave equations in so-called characteristic components. The gradient coupling terms can then be separated in vertical incidence, and oblique incidence components. Expressions are derived for the mode transfer reflection coefficients, and mode transmission coefficients for an arbitrary, stratified magneto-ionic medium. Several propagation cases, also with characteristic mode or z-component coupling, are discussed in the report. Author (TAB)

N67-14980# North Carolina State Coll., Raleigh. Dept. of Mathematics and Physical Sciences Research.
**MATHEMATICAL ANALYSIS OF RESONANT OSCILLATIONS**
Final Report, 15 Jul. 1965-31 Aug. 1966
Raimond A. Struble 30 Sep. 1965 4 p
(Grant DA-ARO(D)-31-124-G630)
(AROD-4105-22; AD-639665) CFSTI: HC $1.00/MF $0.50

Research concerned with the questions of periodic motion in conservative Hamiltonian systems is summarized.
Author (TAB)

N67-14991# Brown Univ., Providence, R. I. Div. of Applied Mathematics.
**GENERALIZED CONTINUUM MECHANICS**
Albert E. Green and Ronald S. Rivlin Aug. 1966 26 p refs
(Contract Nonr-562(40))
(TR-18; AD-640008) CFSTI: HC $2.00/MF $0.50

The deformation in a body is described by a number of generalized coordinate fields. To each of these correspond conjugate body and surface force fields. From the first and second laws of thermodynamics and invariance considerations the field equations of the theory are derived. Director, multipolar and multiple displacement theories arise as special cases. Author (TAB)

N67-15043# General Electric Co., Philadelphia, Pa. Missile and Space Div.
**DESIGN AND ANALYSIS OF SOLID AND HOLLOW CUBE CORNER REFLECTORS AND HOLDERS**
William M. Meyers 15 Jul. 1966 77 p refs
(Contract AF 19(628)-5841)
(AFCRL-66-563; Doc.-66SD4431; SR-1; AD-640497) CFSTI: HC $3.00/MF $0.75

The report describes the design and analysis of two types of cube corner reflectors, solid and hollow. If placed on the lunar surface with the aid of suitable soft landing spacecraft optical cube corners could be used with an earth laser system for selenodetic studies of the moon. With proper sun shielding, it should be possible to operate the cube corner reflector system during 100 percent of the lunar night and approximately 30 to 50 percent of the lunar day. Considering the displacement (due to velocity aberration) of the returned signal to colocated sending/ receiving optics to the observatory by a lunar retroreflector, a maximum return is obtained using a reflector aperture of 11 centimeters for laser radiation of 7000A. The advantages and disadvantages of the hollow and solid cube corner designs are discussed. Final decision as to the one which is most suited to this application must await the outcome of environmental testing. Author (TAB)

N67-15080# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CALCULATION OF A MONO-PULSE OF A QUANTUM GENERATOR AT INSTANTANEOUS CONNECTION OF INTERFEROMETER**
A. M. Samson and V. A. Savva 25 Apr. 1966 10 p refs
Transl. into ENGLISH from Dokl. Akad. Nauk Belorussk. SSR (Minsk), v. 9, no. 1, 1965 p 22-26
(FTD-TT-65-2001; TT-66-61809; AD-640249) CFSTI: HC $1.00/MF $0.50

Formulae are given which permit the evaluation of some basic characteristics of a mono-pulse quantum generator (laser) connected to an interferometer in relation to population inversion, pumping power, mirror reflectivity, and other parameters. TAB

N67-15063# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
**CALCULATION OF UPPER BOUNDS TO THE SMALL-ANGLE SCATTERING FROM CRYSTALLITE MODELS OF AMORPHOUS MATERIALS**
Arthur Bienenstock and Brian G. Bagley Jul. 1966 39 p refs
(Contract Nonr-1866(50); ARPA SD-88)
(TR-7; AD-640186) CFSTI: HC $2.00/MF $0.50

The ability of experimentalists to observe small-angle x-ray scattering from single phase liquids and amorphous solids has been considered, by many workers in the field, to invalidate a crystallite model for these materials. In this work calculation is made of the intensity of small-angle x-ray scattering from two crystallite models which are designed to yield upper bounds to the actual scattering. The calculated upper bounds are, in general, considerably lower in intensity than the scattering from isolated particles. The results are extremely sensitive to the density and average crystallite size of the sample, so that general conclusions about the observability of such scattering cannot be made. The particular case of vitreous SiO2, which was examined experimentally by B. E. Warren and D. L. Weinberg was studied in detail. For this case, the calculated scattering intensity is of the same order of magnitude as that observed by these authors. Thus, it is concluded that the failure to observe small-angle scattering from vitreous SiO2 does not invalidate a crystallite model for that material. It should be noted that the calculation does not, on the other hand, offer any evidence for the existence of crystallites. Author (TAB)

N67-15175# Joint Publications Research Service, Washington, D. C.
**THE FORMATION OF THERMIONS BY EMITTERS**
M. S. Chupakhin 13 Jan. 1967 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 169, no. 2, 1966 p 328–331
(JPRS-39525; TT-67-30175)

A three-strip thermion source was used in comparing the capacities for ion formation of the following sorbents widely used in mass spectrometry: silicagel, aluminum silicagel, and zirconium silicagel. Experiments were conducted in which tungsten, platinum, and iridium were used as the evaporator, with one of the two side strips of the source made of tungsten foil and used as the ionizer. In some of the experiments the role of the evaporator was played by a side strip, and the center strip was the ionizer. The indicator elements were lead and zinc, controlled weights of which were applied to the surface of the sorbents from nitric acid solutions of their salts. Included are various procedures and operations followed in conducting the experiments, along with preliminary results and theoretical justifications. C.T.C.

N67-15282# Institute of Modern Languages, Inc., Washington, D. C.
**THE ILLUMINATION OF SPECTROGRAPHS BY LENTICULAR SCREENS [DIE AUSLEUCHTUNG VON SPEKTROGRAPHEN MIT LINSENRASTERN]**
Ekkehard Preuss Aug. 1966 23 p Transl. into ENGLISH from Beitr. Mineral. Petrog. (Berlin), v. 4, 1954 p 163–171
(Contract DA-44-009-AMC-1563(T))
(T-1871-66; TT-66-62541; AD-641276) CFSTI: HC $1.00/MF $0.50

The image of the lightsource in quantitative spectral analysis is usually projected into the optical system with a lens in front of the slit. The intensity ratio in the spectrum may not be presented correctly if part of the image of the light source is lost in the set of prisms due to vignetting or by absorption and glare. Lenticular screens are used in a special illumination design. This way a multiple image of the light source will be produced and the optical system of the spectrograph will be illuminated uniformly and reproducibly. Author (TAB)

# 24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N67-14398*# Maryland Univ., College Park. Inst. for Molecular Physics.
**ADIABATIC EXCITATION TRANSFER IN GASES: EFFECTS ON TRANSPORT**
Carl Nyeland and E. A. Mason 22 Dec. 1966 22 p refs
(Grant NsG-5-59)
(NASA-CR-80872; IMP-NASA-58) CFSTI: HC $1.00/MF $0.50 CSCL 20H

A calculation is made of the contribution to the transport coefficients from adiabatic excitation transfer in atomic gases. Atomic nitrogen is chosen as an example, and the necessary potential curves are determined partly from spectroscopic data and partly from Heitler–London calculations. Exchange greatly reduces the rate of diffusion of internal electronic energy, and the contribution of the $^2D$ and $^2P$ excited states of N to the thermal conductivity at 10,000°K is reduced by a factor of three (from 48% to 16% of the translational thermal conductivity). Reasons are given to suppose that such behavior is fairly general, and not restricted to nitrogen. Author

N67-14616# Iowa State Univ. of Science and Technology, Ames. Ames Lab.
**RESEARCH REPORT IN PHYSICS**
F. H. Spedding, D. J. Zaffarano, R. G. Barnes, B. C. Carlson, B. C. Cook et al. *In its* Chem., Eng., Met., Phys. and Reactor Div. Jul. 1966 79 p refs (See N67-14612 05-34) CFSTI: HC $7.94/MF $2.25

Accomplishments in the fields of solid state physics and low-, medium-, and high-energy physics are presented. Specific topics treated in crystal physics are electronic properties of metals, electronic structure of crystalline solids, cryophysics, thermal and thermodynamic properties of solids, semiconductors and compounds with variable stoichiometry, magnetic materials, ionic crystals and color centers, and neutron scattering in solids. S.P.

N67-14681# Norsk Radiumhospital, Oslo.
**INDUCED RADIOACTIVITY IN THE COLLIMATOR SYSTEM OF A 31 Mev BROWN BOVERI BETATRON**
Aksel Stroemme [1966] 9 p refs Revised
(Contract AT(30-1)-3364)
(NYO-3364-7) CFSTI: HC $1.00/MF $0.50

An investigation of the induced radioactivity in the collimator system of the BBC 12 Mev betatron is presented. Handling of the collimator system by personnel and radiation hazards due to induced radioactivity are discussed. NSA

N67-14683# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
**DECAY MODE OF $^{160}$Ho [SKHEMA RASPADA $^{160}$He]**
N. A. Bonch-Osmolovskaya, Ya. Vrzal, E. P. Grigor'ev, Ya. Liptak, and Ya. Urbanets 1966 18 p refs In RUSSIAN
(JINR-P-2817)

The decay mode of $^{610}$Ho was studied. The $\gamma$ spectrum was investigated using a semiconductor spectrometer with a germanium detector. The $\gamma$ intensities and multipolarities of gamma transitions were determined. New data were introduced into the decay mode of $^{160}$Ho. Author (NSA)

N67-14687# California Univ., Livermore. Lawrence Radiation Lab.

**ELASTIC AND INELASTIC PROTON–PROTON SCATTERING: A BIBLIOGRAPHY**

Carlotta V. Schauer 28 Mar. 1966 24 p refs
(Contract W-7405-ENG-48)
(UCRL-14716) CFSTI: HC $1.00/MF $0.50

A selective bibliography is presented on elastic and inelastic proton–proton scattering covering the period 1960 to January 1966. References were compiled from Chemical Abstracts, Nuclear Science Abstracts, and Physics Abstracts. NSA

N67-14690# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics.

**THE DECAY OF $Re^{184}$ [ISSLEDOVANIE IZLUCHENIYA $Re^{184}$]**

V. Ageev, Ya. Vrzal, A. Klimenko, Ya. Liptak, V. Maidanyuk et al 1966 12 p refs In RUSSIAN
(JINR-P-2814)

Gamma spectra and conversion–electron spectra from the decay of $^{184}$Re were measured using a Ge(Li) spectrometer and a magnetic $\beta$ spectrometer, respectively. Internal-conversion coefficients were determined together with transition multipolarities. NSA

N67-14691# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

**CLASSIFICATION OF SYSTEMS OF GENERALIZED WAVE FUNCTIONS, REALIZING THE REPRESENTATIONS OF L(m,n) AND P(m,n) GROUPS [KLASSIFIKATSIYA SISTEM OBOBSHCHENNYKH VOLNOVYKH FUNKTSII, REALIZUYUSHCHIKH PREDSTAVLENIYA L(m,n) I P(m,n) GRUPP]**

M. B. Sheftel 1966 20 p refs In RUSSIAN Submitted for Publication
(JINR-P-2785)

The class of unitary irreducible representations of the groups L(m,n) and P(m,n) is considered which is dependent on one parameter only and realized in the eigenfunction space of the multidimensional Laplacian for the space R. The rules for constructing coordinate systems in R are formulated which are necessary for the classification of the basis functions corresponding to any given chain of subgroups and also the rules are formulated for constructing the system of the basis functions itself in these coordinates. The problem is discussed of the normalization of the basis by methods of the integral geometry. Author (NSA)

N67-14692# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.

**$C^{12}$ FAST NEUTRON CROSS SECTIONS AND LEGENDRE MOMENTS BELOW 15.0 Mev**

E. L. Slaggie and J. T. Reynolds 30 Jun. 1966 30 p refs
(Contract W-31-109-ENG-52)
(KAPL-3099) CFSTI: HC $2.00/MF $0.50

An evaluated library of cross sections and elastic scattering Legendre moments is given for $^{12}$C between 0.01 and 15 Mev. The cross sections below 4 Mev and the moments below 7 Mev were calculated using a fitting formula based on a combined resonance and potential well theory. Above 8.4 Mev, the moments were obtained from a nonspherical optical potential calculation. These calculations are described. 46 references. Author (NSA)

N67-14694# Los Alamos Scientific Lab., N. Mex.

**STUDIES OF (D,PF) AND (T,PF) REACTIONS ON PLUTONIUM ISOTOPES**

H. C. Britt, R. W. Newsome, Jr., and R. H. Stokes [1966] 8 p refs Presented at the Symp. on Recent Progr. in Nucl. Phys. with Tandems, Heidelberg, 18–21 Jul. 1966
(Contract W-7405-ENG-36)
(LA-DC-7878; CONF-660716-1) CFSTI: HC $1.00/MF $0.50

The transition states available at the saddle point of fissioning $^{239}$Pu and $^{240}$Pu nuclei are studied by measuring the angular correlation of fragments from the fissioning nuclei excited in direct reactions. The experiments involve measuring proton spectra at laboratory angles of 120° and 130° for (t,pf) and (d,pf) reactions, respectively, in coincidence with fission fragments emitted at angles of 90° or 180° relative to the kinematic recoil angles for the fissioning nucleus. Experimental anisotropies are plotted vs. excitation energy from below threshold to 10 Mev. For each reaction, the relative fission probability ($p_f = \sigma_f/\sigma_p$ was approximately determined by integrating the fission angular correlations over all angles, assuming no azimuthal asymmetry. NSA

N67-14725# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

**COMPUTATION OF NUCLIDE YIELD IN A 60-INCH CYCLOTRON**

William Liben Jul. 1966 73 p refs
(Contract NOw-62-0604-c)
(TG-837; AD-639919) CFSTI: HC $3.00/MF $0.75

Two procedures are described for computing the yield of isotopes in a 60 in. cyclotron. Both are based on the basic yield equation $\sigma(E)N_P(N_T)$, where $\sigma$ is the excitation function, $N_P$ the number of bombarding particles, and $N_T$ the number of target atoms. The excitation function is only available from laboratory measurements. $N_P$ is proportional to the cyclotron beam current and is constant with time and position in the target, but the particle energy decreases as it penetrates into the target. The yield depends upon $N_P(N)(\sigma)dx$ where $N$ is the number of target atoms per cubic centimeter and $dx$ is a thin slice of the target. A rough approximation to the yield is possible if $\sigma$ is taken to be constant. The yield is then given by $N_P(N)(\sigma)$ (range). The stopping power $de/dx$ is discussed in detail, including methods for computing the function. Detailed computations are given for the $B_{10}(d,n)C_{11}$ reaction using rough and more exact procedures. In the appendix are collected the yield curves for a few short-lived isotopes useful in making radiopharmaceuticals. Author (TAB)

N67-14768# General Electric Co., Schenectady, N. Y. Research and Development Center.

**ELECTRON–MOLECULE COLLISION CROSS SECTIONS IN HELIUM AND ARGON MEASURED BY A TIME-OF-FLIGHT TECHNIQUE**

G. C. Baldwin Aug. 1966 6 p refs
(Contract Nonr-3942(00))
(Rept.-66-C-246; AD-639852) CFSTI: HC $1.00/MF $0.50

The total collision cross sections of helium and argon for electrons of very low energy have been measured by a new technique employing time-of-flight velocity selection. The present measurements extend below 200 MeV; the ultimate limit of the technique is about one decade lower. Helium shows a 6 sq. a cross section, decreasing monotonically below 400 MeV with no structure. The argon cross section falls from 1.6 sq. a at 1 volt to a minimum of 0.4 sq. a at 300 MeV, and then rises steeply. Author (TAB)

N67-14848# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).

**REMARKS ON CLASSICAL UNSTABLE PARTICLES AND THE LONG-RANGE SCALAR FIELD**

J. Leite Lopes Oct. 1966 11 p ref
(TH/169) CFSTI: HC $1.00/MF $0.50

A possible description of unstable particles, classically defined as those with a rest-mass depending on proper time, is examined. If one assumes the equality between inertial and gravitational masses valid for both stable and unstable particles, a universal interaction between a zero-mass scalar field and all particles, which would thus have a variable rest-mass, is allowed by this equality and has been proposed by Dicke in connection with Mach's principle. Author

N67-14847# Aktiebolaget Atomenergi, Stockholm (Sweden).
**NOMOGRAM FOR DETERMINING SHIELD THICKNESS FOR POINT AND LINE SOURCES OF GAMMA RAYS**
C. Josenemalm and K. Malen Oct. 1966 35 p refs
(AE-252) CFSTI: HC $2.00/MF $0.50

A set of nomograms is given for the determination of the required shield thickness against gamma radiation. The sources handled are point and infinite line sources with shields of Pb, Fe, magnetite concrete ($\rho$=3.6), ordinary concrete ($\rho$=2.3) or water. The gamma energy range covered is 0.5–10 MeV. The nomograms are directly applicable for source and dose points on the surfaces of the shield. They can easily be extended to source and dose points in other positions by applying a geometrical correction. Also included are data for calculation of the source strength for the most common materials and for fission product sources. Author

N67-14927*# GCA Technology Div., GCA Corp., Bedford, Mass.
**MASS SPECTROMETER ANALYSIS OF SOLID MATERIALS WITH THE ION-MICROPROBE SPUTTER SOURCE**
R. F. K. Herzog, W. P. Poschenrieder, and F. G. Satkiewicz Washington, NASA, Jan. 1967 43 p refs
(Contract NAS5-9254)
(NASA-CR-683) CFSTI: HC $2.00/MF $0.65 CSCL 20H

Several instrumental improvements to the sputter ion source mass spectrometer are described, with the introduction of the so-called energy window considered of great importance. It makes uses of the discovery that the initial energy distribution of atomic ions differs significantly from the energy distribution of molecular ions. When the energy window is properly set, either predominantly atomic or molecular spectra can be obtained. Very heavy molecules such as $Al_{18}$ can be detected. These molucules may be regarded as microcrystalline units of the material and their composition obviously reflects the crystalline structure of the material. The potential use of the instrument for a more sophisticated analysis of solids is stressed. Geological applications are discussed, and data given on the analysis of two samples. The possibility of measuring low concentration isotope ratios in the strontium and rare earth region in the complex matrix of a rock was investigated, including the selection and preparation of proper fluxing agents. Author

N67-14979# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**DIELECTRIC LOSSES SITUATED IN AN IONIZING RADIATION FIELD**
V. K. Zhuravlev 6 Jun. 1966 13 p refs Transl. into ENGLISH from Izv. Vysshikh Uchebn. Zavedenii, Fiz. (Tomsk), no. 5, 1964 p 96-90
(FTD-TT-65-398; TT-66-62345; AD-639482) CFSTI: HC $1.00/MF $0.50

The article discusses the relaxation polarization at the effect of ionizing radiation of low intensity, when the irreversible changes in the dielectric can be disregarded. It is shown, that the appearance of hot molecules on account of radiation energy absorption, may lead to acceleration as well as to slow down of dielectric relaxations, and also to an increase or decrease of dielectric losses. Author (TAB)

N67-15032# Alabama Univ., University.
**EFFECT OF THE TWO-PARTICLE SPIN-ORBIT NUCLEON-NUCLEON INTERACTION ON THE $O^{16}$ AND $N^{16}$ NUCLEI** Interim Technical Report
Byron L. Coulter Aug. 1966 86 p refs Sponsored in part by NASA
(Grant DA-ARO(D)-31-124-G664)
(NASA-CR-81069; ARO(D)-4619-3; ITR-2; AD-642510) CFSTI: HC $3.00/MF $0.65

Possible nucleon-nucleon interaction potentials are considered, and the form is selected which is though necessary to obtain a reasonably accurate picture of the $O_{16}$ and $N_{16}$ Nuclei without necessarily complicating the calculations. Then the assumptions made to approximate the solution of the Schrodinger equation are discussed, and the potential well introduced by these assumptions is chosen. A mathematical treatment of the methods used for constructing the energy matrices is presented. Theoretical predictions of the energy-level splittings of $O_{16}$ and $N_{16}$ and of the Beta-decay and muon-capture rates for the two nuclei are given. After a comparison of these results with experimental data, the nuclear state vectors giving the best experimental fit are chosen. The appendices contain three derivations too cumbersome to be included in the main text, but necessary for the completeness of the work, and a summary of formulas from Racah algebra which are used through the calculations. Author (TAB)

N67-15087# Stanford Univ., Calif. High Energy Physics Lab.
**EXCITATION OF A 19-MeV LEVEL IN $C^{12}$ BY ELASTIC ELECTRON SCATTERING**
Hall Crannell, Harvey A. Dahl, and F. H. Lewis, Jr. Mar. 1966 15 p refs Submitted for Publication
(Contracts Nonr-225(67); AF 49(638)-1389)
(HEPL-432; ITP-208; AD-639800) CFSTI: HC $1.00/MF $0.50

Measurements of inelastic electron scattering cross sections for Carbon-12 were made for transitions to a level at approximately 19.5 MeV. The cross section peak corresponding to excitation of this level is clearly visible above the inelastic continuum over the range of momentum transfers from 267 MeV/c to 643 MeV/c at electron scattering angles between 40 degrees and 48 degrees. Form factors derived from the experimental data are compared to theoretical form factors calculated by assuming the excitation involves a single-particle dipole transition to a T = 1, J = 1- state. A search for levels with higher excitation energies was also undertaken, special attention being focused on the region 30 MeV to 45 MeV. This failed to uncover, within the experimental sensitivity, any levels with excitation energy greater than 20 MeV. Author (TAB)

N67-15109# Ballistic Research Labs., Aberdeen Proving Ground, Md.
**INDEX OF REFRACTION OF EXCITED MONATOMIC GASES**
Robert A. Rudd Jul. 1966 20 p refs
(BRL-MR-1772; AD-641387) CFSTI: HC $1.00/MF $0.50

The average polarizability per particle is formulated for an excited monatomic gas. In contrast to the usual procedure of neglecting excited state contributions, a lower bound is obtained considering only atomic excited states. The result shows that for an equilibrium argon plasma previous values of the effective polarizability may be too small by at least a factor of two. Author (TAB)

N67-15211*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
**NEUTRINOS, HELIUM FLASH, AND WHITE DWARFS**
Hong-Yee Chiu [1963] 7 p refs
(NASA-TM-X-59255) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The effect of neutrino processes in delaying or stopping helium burning (and carbon burning) in certain red giants is discussed. Previously derived equations for calculating the neutrino energy flux from the core of a red giant model are given. Since in the plasma neutrino process the energy loss rate increases as the density increases (and as the core mass increases), an equation is derived to give the lower limit for the increase in the core mass necessary to raise its temperature to the helium burning point. This equation is valid for red giants of solar masses from 0.7 to 1.3. It is pointed out that the same analysis may not be applied to a star just prior to the carbon burning stage because the neutrino flux is very large. L.E.W.

N67-15284# Syracuse Univ., N. Y.
**[REVIEW-TYPE AND PURELY EXPERIMENTAL PROJECTS] Progress Report**
Jack Leitner 30 Jun. 1966 5 p refs
(Contract Nonr-669(12))
(AD-639864) CFSTI: HC $1.00/MF $0.50

Progress in experimental studies involving the following topics is briefly summarized: properties of the f°, properties of the K°°, measurement of the neutral-K1 - neutral K2 mass difference via the strangeness oscillation technique, branching ratios of the Y1*(1660) hyperon, estimate of the negative-omega branching ratios, study of negative-Xi final states. TAB

N67-15293# Naval Civil Engineering Lab., Port Hueneme, Calif.
**A RANDOM WALK TREATMENT OF NEUTRON DIFFUSION IN SLABS Technical Report, Jul. 1965–May 1966**
M. L. Eaton and C. M. Huddleston Sep. 1966 43 p refs
(TR-482; AD-640260) CFSTI: HC $2.00/MF $0.50

The concept of a Markov chain was used to treat the random process of scatter and absorption which occur when neutrons are incident on a slab of finite thickness, such as a shield or an inside wall of a shelter entraceway. It is assumed that scattering is isotropic in the laboratory system and that the scattering and absorption cross sections do not change during a neutron-scattering history. The encouraging results obtained to date indicate that for thin slabs the analytical random walk method may have important advantages over Monte Carlo calculations (which require lengthy computer runs to obtain acceptably small statistical variances), moments method calculations (which are actually appropriate only for infinite medium cases), and numerical solutions of the neutron transport equation (which are lengthy, tedious, and necessarily approximate). Author (TAB)

# 25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N67-14459*# Michigan Univ., Ann Arbor.
**ON THE RADIATION OF A MAGNETIC LINE SOURCE EXCITED CYLINDER THROUGH AN AXIALLY SLOTTED PLASMA SHEATH**
Andreas Otte Washington, NASA, Jan. 1967 63 p refs
(Grant NsG-472)
(NASA-CR-677) CFSTI: HC $2.50/MF $0.75 CSCL 20I

A plasma sheath encloses a perfectly conducting cylinder with a time harmonic magnetic line source on its surface. The plasma sheath has an infinite axial slot. A singular integral equation is formulated for the electric plasma current whose solution unfortunately was not found. However, some approximations for the current of underdense plasma are suggested to predict the effect of the slotted plasma sheath on the cylinder radiation. For overdense plasma the slot may support traveling waves which transport power from the source to the external space. Radiation is calculated through a narrow parallel face slot that supports the propagation only of the lowest order mode. It is shown that the radiation in the forward direction is comparable to the case of no plasma sheath. Author

N67-14490*# Indian Inst. of Tech., Bombay.
**STABILITY OF FLOW OF A NON-NEWTONIAN LIQUID BETWEEN TWO ROTATING CYLINDERS IN THE PRESENCE OF A CIRCULAR MAGNETIC FIELD**
M. N. L. Narasimhan *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 345–369 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

The problem of stability of a non-Newtonian Couette flow in the presence of a circular magnetic field between coaxial circular cylinders has been reduced to a characteristic value problem by assuming the spacing between the cylinders to be small. The mode of marginal stability is determined by solving this characteristic value problem. A convectional pattern of instability is found to set in and the occurrence of this instability is determined in terms of critical Taylor numbers as stability criteria. The numerical results are obtained for the cases of co-rotating and counter-rotating cylinders. The results of Table I are obtained for the non-Newtonian case. Then by putting $\nu_1 = 0$, the corresponding results for the classical viscous fluid case are obtained in Table II. The case $Q = 0$ gives the results for the nonmagnetic case. The main results of this investigation are that the effect of cross viscosity is found to facilitate the onset of instability and therefore the non-Newtonian Couette flow is found to be less stable than the Newtonian Couette flow in the presence of a circular magnetic field. Thus the role of cross viscosity in the present case is opposite to that of viscosity, since the viscosity effect is known to stabilize the flow under similar conditions. Author

N67-14619# Aeronautical Research Council (Gt. Brit.)
**THE MAGNETIC DEFLECTION OF SHORT ARCS ROTATING BETWEEN ANNULAR ELECTRODES ABOVE AND BELOW ATMOSPHERIC PRESSURE**
E. D. Blix and A. E. Guile (Leeds Univ.) London, HMSO, 1966 49 p refs Supersedes ARC-26288
(ARC-CP-843; ARC-26268) CFSTI: HC $2.00/MF $0.50

An apparatus has been designed and constructed in which arcs of up to 5 kA, at inter-electrode spacings up to 2.5 cm, can rotate around ring-shaped electrodes in radial magnetic fields up to 0.2 $Wb/m^2$, in different gases between vacuum and 20 atmospheres. Preliminary results are described for arcs in air, nitrogen, hydrogen and sulphur hexafluoride, at a spacing of 2 mm, at pressures between 1.5 torr and 14 atmospheres and at currents up to 350 A, on brass and aluminum electrodes. In contrast to earlier experiments under similar conditions, except that the arc then ran once along rail electrodes and the cathode site transfer conditions were critical, these experiments have shown that the interaction of the arc column with the gas has been predominant at pressures above one to one and a half atmospheres. Author

N67-14627*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**PHYSICAL ACOUSTICS**
J. L. Macon *In its* Res. Lab. of Electron. 15 Oct. 1966 p 35–38 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25
(Contracts Nonr-1841(42); DA-36-039-AMC-03200(E))

Brief summaries are given of the following two studies: (1) The energy transfer mechanism for the amplification of acoustic waves in a weakly ionized gas was applied to ion-acoustic waves in a fully ionized gas. It was assumed that the electron temperature remains constant during the period of an ion-acoustic oscillation. With the ions treated adiabatically and the various possible ion-acoustic loss terms ignored, the resulting amplification is of the order $T_i/T_e$ times the amplification calculated for acoustic waves in a weakly ionized gas having the same electron density and temperature. (2) Preliminary experimental evidence was obtained in support of the theory that sound waves are amplified as they pass through a plasma. This was found to result from an in-phase heating of the neutrals by the hot electron gas. The experimental arrangement is described, which essentially consists of a cold helium discharge at a pressure of 18 mm Hg maintained in a long cylindrical tube 2 inch in diameter with a speaker at one end and a microphone at the other. E.W.

N67-14628*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**PLASMA PHYSICS**

J. C. Ingraham, G. Lampis, and R. L. Kronquist *In its* Res. Lab. of Electron. 15 Oct. 1966 p 37-58 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25
(Contract AT(30-1)-1842)

The following three studies are discussed: (1) Calculated was an ion-wave instability that can occur in a steady-state discharge in which no electric current exists. It was assumed that all other plasma instabilities are absent, that the plasma is weakly ionized, and that electron-ion collisions are negligible. (2) A laser breakdown experiment was conducted to determine the transmission rate of the gas laser power (HeNe) through the plasma. The purpose was to gain knowledge of the absorption coefficient of the light at 6328 Å and to measure the dimensions of the plasma during its evolution in time. The pulse from the ruby laser was stabilized to the power of 50 MW (2 J in 40 nsec). The gas was helium at 10.25 kg/cm$^2$ pressure. (3) Experiments were conducted to observe microwave scattering from density fluctuations in a plasma produced by firing an electron beam into un-ionized mercury vapor. Evidence indicated that the scattering is from plasma waves, excited by the electron beam, which reflect from the ends of the plasma column and form standing waves along the axis of the tube. K.W.

**N67-14629*#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**GASEOUS ELECTRONICS**
B. L. Wright *In its* Res. Lab. of Electron. 15 Oct. 1965 p 59-64 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25
(Contract DA-36-039-AMC-03200(E))

The Boltzmann equation is used in a theoretical treatment of the behavior of a weakly ionized plasma. The results are compared with those obtained by a method used previously, in which the velocity distribution of electrons in a plasma was derived from measurements of the spectrum of emitted microwave radiation. The previous results illustrated the time dependence of the distribution function early in the afterglow of a weakly ionized argon discharge. In comparing the observed and expected behavior of the electron velocity distribution it is found that both the experimental method and the present theoretical model are substantiated. K.W.

**N67-14630*#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**PLASMAS AND CONTROLLED NUCLEAR FUSION**
A. Bers, R. R. Bartsch, S. R. J. Brueck, C. E. Wagner, and L. M. Lidsky *In its* Res. Lab. of Electron. 15 Oct. 1966 p 65-77 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25
(Grants NSF GK-57; NSF GK-1165)

Outlines and some results are presented of the following work: (1) in beam-plasma discharges, operations with Asco and Marshall valve gas injections in which measurements were made of plasma density as a function of time, and in which decay stability was observed following discharges; (2) high-frequency electron-phonon interactions in a magnetic field, in which the electron dispersion relation is analyzed when interacting with acoustic waves in a solid, in a zero magnetic field, and in a finite magnetic field; and (3) a stuffed-cusp plasma experiment, in which construction and operation of the experimental apparatus are briefly mentioned. K.W.

**N67-14631*#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**ENERGY CONVERSION RESEARCH**
J. L. Kerrebrock, M. A. Hoffman, G. C. Oates, and R. Decher *In its* Res. Lab. of Electron. 15 Oct. 1966 p 79-93 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25
(Contract AF 33(615)-3489)

Described is the design of a large, nonequilibrium, segmented-electrode MHD generator which was not to exhibit the electrode shorting phenomenon and still be capable of elevation of the electron temperature above the gas stagnation temperature. Used in the study was a graphite inert-gas heater capable of a flow of 0.4 kg s$^{-1}$ of helium at 2000°K stagnation temperature and 5 atm stagnation pressure. The hot plasma for use in the experiment was supplied by a large heat-sink facility. The test gas was supplied from a manifold of up to 20 gas bottles and is delivered through two stages of regulators in series to the inlet at the bottom of the heater. Described are channel geometry, electrode-wall design, insulator-wall design, and use of an external exciter. Results are given for eight runs: two with boron-nitride side walls, and six with iron-peg walls. From preliminary results it is concluded that the behavior of the insulator boundary layer is a crucial factor in the performance of supersonic inert-gas generators. Indications are that the performance is not limited by the electrode shorting phenomenon. K.W.

**N67-14704#** Innsbruck Univ. (Austria). Inst. for Theoretical Physics.
**MAGNETOGASDYNAMIC FLOWS OF SMALL MAGNETIC REYNOLD'S NUMBER, PART II**
Karl Lackner 25 Jun. 1966 35 p refs
(Contract AF 61(052)-675)
(AFOSR-66-2252; SR-31; AD-640486)

A two-dimensional method is described for computing the performance of steady crossed field accelerators, neglecting Hall currents. The results are compared to those of the usual quasi-one dimensional calculations, and the methods described were applied to two numerical examples. Finally, the method is extended to include cases in which the Hall effect cannot be neglected. L.E.W.

**N67-14731#** General Electric Co., Philadelphia, Pa. Missile and Space Div.
**MHD GENERATOR AND ACCELERATOR EXPERIMENTS IN SEEDED AND UNSEEDED AIR FLOWS**
Clarence J. Harris, Charles H. Marston, and Walter R. Warren, Jr. Sep. 1966 29 p refs Presented at the Intern. Symp. on MHD Elec. Power Géneration, Salzburg, Austria, 4-8 Jul. 1966
(Contracts AF 04(647)-269; AF 40(600)-1091)
(R66SD50; AD-639754) CFSTI: HC $2.00/MF $0.50

Two types of MHD experiments were conducted using air flows produced by hypersonic shock tunnels. One experimental program was designed to evaluate the feasibility of using the Lorenz forces developed in an MHD generator for the attitude control of a hypervelocity vehicle. During this study the electrical conductivity of the seeded shock layer flow about a blunt model located in the shock tunnel test section was investigated along with the effect of pre-heating the generator electrodes. In the second experimental program, a Faraday accelerator is being studied to determine its ability to add kinetic energy to a high density, unseeded air flow in a high enthalpy shock tunnel. Measurements were made of the gross electrical conductivity of the flow, with and without an applied magnetic field. The meaning of the electrical conductivity measurements for each of these experiments is discussed. Author (TAB)

**N67-14817*#** Michigan Univ., Ann Arbor. Electron Physics Lab.
**DISPERSION RELATIONS FOR A MAGNETOACTIVE FINITE TEMPERATURE PLASMA**
H. C. Hsieh Sep. 1966 65 p refs
(Grant NsG-696)
(NASA-CR-80914; TR-95) CFSTI: HC $3.00/MF $0.75 CSCL 20I

The dispersion relation for a finite temperature magnetoactive plasma is derived in a form particularly suitable for the study of the effects of transverse static electric and magnetic fields upon the coupling between the transverse and longitudinal modes. The

derivation is based on the coupled Boltzmann–Vlasov–Maxwell equations under the one-dimensional small-signal assumptions. The time-varying parts of the particle distribution functions for a two-component plasma are divided into three parts; namely, those associated respectively with the right-hand and left-hand circularly polarized transverse waves and that associated with the longitudinal mode. The mode coupling equation, which relates the dynamic electric fields of these modes, is derived in terms of the time-independent part of the distribution function for two cases: longitudinal propagation in the presence of a transverse static electric field, and oblique propagation in the absence of static electric field. If the time-independent portions of the distribution functions are taken to be Maxwellian it is shown that in the low-temperature limit the dispersion relationship reduces to the familiar expression for the cold plasma. Possible applications of the derived dispersion relationship are briefly discussed. Author

**N67-14983#** California Univ., Los Angeles. Plasma Physics Group.

**THE GUIDING CENTER APPROXIMATION IN LOWEST ORDER**

Alfredo Banos, Jr. Sep. 1966 31 p

(Contract Nonr-4756(01))

(R-9; AD-641281) CFSTI: HC $2.00/MF $0.50

The report is concerned with a simple and direct derivation of the equations governing the motion of a charged particle in space and time dependent electric and magnetic fields in the so-called guiding center approximation. Attention is given exclusively to results in lowest order in an expansion in reciprocal powers of the cyclotron frequency. As is well known, results to lowest order are the most frequently employed for practical as well as for didactic reasons. Yet, to the authors knowledge, there appear to be no elementary derivations of these results, which are at once general and comprehensive, but which do not employ the complicated machinery of the formal asymptotic expansions of Bogolyubov and Zubarev and of Kruskal. TAB

**N67-14990#** Royal Inst. of Tech., Stockholm (Sweden). Microwave Dept.

**GENERATION AND AMPLIFICATION OF MICROWAVES BY INTERACTION OF ELECTRON BEAMS AND PLASMA**

Annual Summary Report, 1 Jun. 1965–31 May 1966

Bertil Agdur 30 Jun. 1966 12 p

(Contract AF 61(052)-895)

(RADC-TR-66-589; ASR-1; AD-640372) CFSTI: HC $1.00/MF $0.50

Among the problems treated are mode coupling in inhomogeneous plasmas, coupling of waves through plasma structures, non-linear wave interaction in plasmas, variation of electron density and neutral gas density along a low pressure mercury vapour discharge, microwave emission from InSb and laser diagnostics of solid state plasmas. Author (TAB)

**N67-15012#** Innsbruck Univ. (Austria). Inst. of Theoretical Physics.

**VARIATIONAL METHOD FOR UNSTEADY ONE-DIMENSIONAL PLASMA FLOW OF THE TYPE V⊥B**

Franz Harnegger 30 Sep. 1966 21 p refs

(Contract AF 61(052)-675)

(AFOSR-66-2464; SR-38; AD-642242)

The well known variational principle of the plane steady gas-dynamical potential flow is generalized to unsteady plane mgd potential flow of the type v perpendicular to B. It is shown that the formulation of the variational principle in the independent variable P (pressure) is possible for arbitrary adiabatic exponent, but the formulation in the velocity potential is possible only for special values of the adiabatic exponent. Author (TAB)

**N67-15016#** Aerospace Research Labs., Wright-Patterson AFB, Ohio.

**ABSORPTION AND EMISSION COEFFICIENT DETERMINATION BY A ZONAL RING TECHNIQUE IN A CIRCULAR CYLINDRICAL PLASMA COLUMN**

John F. Oss Jun. 1966 67 p refs

(ARL-66-0110; AD-641145) CFSTI: HC $3.00/MF $0.75

An automated data acquisition and reduction system is described for obtaining absorption and emission coefficients in a circular cylindrical plasma column. The data reduction is based on a zonal ring method with the absorption coefficient accounted for in the emission coefficient calculations. Computer programs are included. Author (TAB)

**N67-15060#** Sylvania Electric Products, Inc., Waltham, Mass. Applied Research Lab.

**GUIDED WAVES SUPPORTED BY LAYERS OF A LOSSY COMPRESSIBLE PLASMA**

J. Galeja 25 Jul. 1966 36 p refs

(Contract AF 19(628)-5718)

(S-5158-3; RR-493; AFCRL-66-552; AD-640064) CFSTI: HC $1.00/MF $0.50

A planar slab of isotropic compressible lossy plasma is bounded either by free space on both sides or by free space and a ground plane, and is excited by line sources. After establishing the dispersion relations the power carried by the waves is calculated. The total power of the many waves which depend on the resonances of the plasma waves in the transverse dimension of the slab is about two orders of magnitude lower than the power of the surface waves guided along the plasma boundary for frequencies which are somewhat higher than the plasma frequency. The excitation efficiency of the transversely resonant waves is decreased for thick layers of a lossy plasma, but the losses can be neglected if the layer thickness is of the order of free space wavelength and the loss tangent of the plasma is less than 0.01. Author (TAB)

**N67-15064#** Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

**SPLITTING OF A NONEVOLUTIONARY PARALLEL SHOCK WAVE**

K. P. Cherkasova 18 Aug. 1966 9 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Mekhan. (USSR), no. 5, 1965 p 146–148

(Contract NOw-62-0604-c)

(TG-230-T488; TT-66-62384; AD-639909) CFSTI: HC $1.00/MF $0.50

It is shown that if the magnetic field is slightly oblique relative to the direction of shock-wave propagation, the waves that form separate. TAB

**N67-15113#** Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

**MINIATURE ENTHALPY PROBES FOR HIGH TEMPERATURE GAS STREAMS** Technical Report, Jan. 1965–Feb. 1966

Franklin A. Vassallo Wright-Patterson AFB, Ohio, AFL, Jun. 1966 64 p refs

(Contract AF 33(615)-2481)

(ARL-66-0115; AD-642280) CFSTI: HC $3.00/MF $0.65

A study is reported in which a number of stagnation enthalpy probes are discussed and their performance experimentally evaluated. Effort is directed to probe instruments which operate on the total calorimetric principle. Prime emphasis is placed on the accuracy and operational characteristics of probes less than 0.1 in. in diameter. Presently available recirculating probe types received important attention, but major consideration is

given to the operation of a new, rapid response, calorimetric probe discussed in the text. Results show the total calorimetric probes which utilize a 'tare' measurement to operate satisfactorily when appropriate corrections to account for gas sample flow are included. Change in probe size is found to have influence primarily on the upper limit of operation of the instrument. Tests of the Avco or 'split-flow' total calorimetric probe type indicate it to have little advantage in miniature size over that of the conventional single flow probe types. Both analytical and experimental studies of rapid response probes show this concept to be significantly better than that of the above types in terms of speed, size, and operational limits. Although the experiments indicate instrument output to be proportional to gas enthalpy as predicted by analysis, insufficient tests have been conducted to establish accuracy of this probe type. Author (TAB)

**N67-15221#** Advisory Group for Aerospace Research and Development, Paris (France).
**FUNDAMENTAL STUDIES OF IONS AND PLASMAS, VOLUME I**
H. Dean Wilsted, ed. (Gen. Motors Corp., Indianapolis) 1965 356 p refs In FRENCH and ENGLISH Proc. of the AGARD–NATO Specialists Meeting, Pisa, Italy, 6–10 Sep. 1965
(AGARD-CP-8, Vol. I) CFSTI: HC $7.00/MF $1.75

CONTENTS:

1. IONIZATION IN HYDROCARBON FLAMES H. F. Calcote (Aerochem Res. Labs., Inc.) p 1–42 refs (See N67-15222 05-33)

2. PROCESSES OF IONIZATION AND RECOMBINATION OF METALLIC ADDITIVES IN FLAMES T. M. Sugden (Shell Res., Ltd.) p 43–64 refs (See N67-15223 05-33)

3. POSITIVE ION COLLECTION BY SPHERICAL PROBES IN HIGH PRESSURE FLAME PLASMAS I. W. Salter and B. E. L. Travers (Rocket Propulsion Establ.) p 65–79 refs (See N67-15224 05-33)

4. SURFACE EFFECTS IN SEEDED COMBUSTION PRODUCTS D. L. Turcotte (Cornell Univ.) p 81–122 refs (See N67-15225 05-33)

5. CONTRIBUTIONS OF ELECTRONS TO IONIZATION IN FLAME GASES A. von Engle and J. R. Cozens (Oxford Univ.) p 123–138 refs (See N67-15226 05-33)

6. CHEMI-IONIZATION IN GASEOUS DETONATIONS J. R. Kelly, T.-y. Toong and C.-c. Tung (Mass. Inst. of Tech.) p 139–159 refs (See N67-15227 05-33)

7. A SIMPLE ELECTROSTATIC PROBE FOR THE MEASUREMENT OF ION DENSITIES IN ATMOSPHERIC PRESSURE FLAMES AND ITS APPLICATION TO A STUDY OF CHARGE EXCHANGE REACTIONS IN HYDROCARBON FLAME GASES R. G. Soundy and H. Williams (Rocket Propulsion Establ.) p 161–189 refs (See N67-15228 05-33)

8. OBSERVATIONS ON NEGATIVE IONS IN HYDROCARBON FLAMES J. A. Green (Shell Res., Ltd.) p 191–214 refs (See N67-15229 05-33)

9. PHYSICS OF SYNTHETIC PLASMA BEAMS J. F. Bonnal, J. Giacomini, G. Mainfray, C. Manus, J. Morellec et al (Commissariat a l'Energie Atomique) p 215–278 refs (See N67-15230 05-25)

10. SPECTROSCOPIC MEASUREMENTS IN DIRECT ENERGY CONVERSION DEVICES H. D. Wilsted, R. T. Schneider, and W. Woerner (Gen. Motors Corp.) p 279–324 refs (See N67-15231 05-25)

11. SOME R.F. AND SPECTROSCOPIC DIAGNOSTIC METHODS OF A HELIUM PLASMA IN A MAGNETIC FIELD P. Caldirola, V. Agnello, N. Barassi, U. Finzi, M. Fontanesi et al (Milan Univ.) p 325–352 refs (See N67-15232 05-25)

12. PLASMA ENERGY TRANSFER TO A SURFACE WITH AND WITHOUT ELECTRIC CURRENT E. R. G. Eckert and E. Pfender (Minn. Univ.) p 353–383 refs (See N67-15233 05-25)

**N67-15230#** Commissariat a l'Energie Atomique, Saclay (France). Services de Physique Appliquée.
**PHYSICS OF SYNTHETIC PLASMA BEAMS [PHYSIQUE DES FAISCEAUX DE PLASMA DE SYNTHESE]**
J. F. Bonnal, J. Giacomini, G. Mainfray, C. Manus, J. Morellec et al *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. I 1965 p 215–278 refs In FRENCH; ENGLISH summary (See N67-15221 05-25) CFSTI: HC $7.00/MF $1.75

Research on synthetic plasma sources and beams is described, and the following are discussed: (1) The electron bombardment ion source. The physical parameters of the plasma are measured and new geometries are suggested for improving the radial distribution of the ion density. (2) The ion beam. The intensity and yields are measured in relation to the parameters of the source. (3) Neutralization of the beam by electron injection. The physical process of neutralization is investigated in detail. Author

**N67-15231#** General Motors Corp., Indianapolis, Ind. Allison Div.
**SPECTROSCOPIC MEASUREMENTS IN DIRECT ENERGY CONVERSION DEVICES**
H. Dean Wilsted, R. T. Schneider, and W. Woerner *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. I 1965 p 279–324 refs (See N67-15221 05-25) CFSTI: HC $7.00/MF $1.75
(Contracts NASw-922; Nonr-4104(00); AF 33(657)-13658)

Spectrographic measurements of plasma properties in direct conversion devices and a cesiated helium arc are summarized. The line reversal technique was used to measure the electron temperature in a magnetoplasmadynamic generator and appeared to give good results; accuracies should be within ±75°K. Both the absolute intensity and relative line intensity methods were used to measure electron temperature in a thermionic generator. The absolute line intensity technique provides a high sensitivity except at near peak line intensity conditions. There are, however, uncertainties in the accuracy of the transition probabilities. Data scatter in the relative line intensity method made it difficult to use and the accuracy was seriously in doubt. The differential line ratio method eliminates the need for transition probabilities, spectral calibration of the photographic plate, and use of a radiation standard. It is concluded that it is relatively easy to use and should improve the accuracy of electron temperature measurements. Author

**N67-15232#** Milan Univ. (Italy). Inst. of Physical Science.
**SOME R.F. AND SPECTROSCOPIC DIAGNOSTIC METHODS OF A HELIUM PLASMA IN A MAGNETIC FIELD**
P. Caldirola, V. Agnello, N. Barassi, U. Finzi, M. Fontanesi et al *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. I 1965 p 325–352 refs (See N67-15221 05-25) CFSTI: HC $7.00/MF $1.75

Some methods of the diagnostics of a low density plasma in the presence of a steady magnetic field are described. Plasma is produced in a low pressure helium by an rf field near gyromagnetic resonance condition. Breakdown fields were measured for several values of the magnetic fields and for some container shapes. A spectroscopic method was applied to measure electron kinetic temperature. A method based on admittance measurements was used to evaluate electron density. Another diagnostic technique developed for the measurement of electron density by means of excitation of characteristic resonances is described. Author

**N67-15233#** Minnesota Univ., Minneapolis. Heat Transfer Lab.
**PLASMA ENERGY TRANSFER TO A SURFACE WITH AND WITHOUT ELECTRIC CURRENT**

E.R.G. Eckart and E. Pfender *In* AGARD , Fundamental Studies of Ions and Plasmas, Vol. I 1965 p 353–383 refs (See N67-15221 05-25) CFSTI: HC $7.00/MF $1.75

Results of heat transfer studies from a hot, dense plasma to a solid surface are compiled and discussed with emphasis on the importance of an electron current from the plasma to such a surface. The energy transfer phenomenon to a surface which does not carry electrical currents is reviewed, and studies are described where electrical currents lead to a significant or even predominant contribution to the observed heat fluxes. Simple energy transfer models are proposed which appear to be helpful, at least for a qualitative description of the observed energy transfer phenomena. Author

**N67-15234#** Advisory Group for Aerospace Research and Development, Paris (France).

**FUNDAMENTAL STUDIES OF IONS AND PLASMAS, VOLUME II**

H. Dean Wilsted, ed. (Gen. Motors Corp., Indianapolis) 1965 352 p refs In FRENCH and ENGLISH Proc. of the AGARD–NATO Specialists Meeting, Pisa, Italy, 6–10 Sep. 1965 (AGARD-CP-8, Vol. II) CFSTI: HC $7.00/MF $1.75

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1. DIAGNOSIS OF A PLASMA BEAM EXTRACTED FROM AN ELECTRON-BOMBARDMENT ION SOURCE W. A. Clayden and C. V. Hurdle (Royal Armament Res. and Develop. Establ.) p 385–418 refs (See N67-15235 05-25)

2. MICROWAVE INTERFEROMETER MEASUREMENTS OF THE ELECTRON DENSITY DISTRIBUTION BEHIND SHOCK FRONTS AND DISCHARGE PLASMAS W. Makios (Inst. fur Plasmaphysik G.m.b.H.) p 419–441 refs (See N67-15236 05-25)

3. ON THE CORRELATION OF EXPERIMENTAL DATA FOR NON-EQUILIBRIUM SEEDED PLASMA R. Monti (Naples Univ.) p 443–471 refs (See N67-15237 05-25)

4. DETERMINATION OF TRANSPORT PROPERTIES OF A PLASMA FROM ARC MEASUREMENTS G. Schmitz and H. J. Patt (Technische Hochschule Aachen) p 473–493 refs (See N67-15238 05-25)

5. IONIZATION EQUATION OF OPTICALLY THIN NON-EQUILIBRIUM PLASMAS W. L. Bohn (Deutsche Versuchsanstalt fur Luft- und Raumfahrt) p 495–515 refs (See N67-15239 05-25)

6. LASER INTERFEROMETER MEASUREMENTS OF RAPID ELECTRON DENSITY CHANGES IN A PLASMA C. B. Wheeler and A. E. Dangor (Imperial Coll. of Sci. and Tech.) p 517–527 ref (See N67-15240 05-25)

7. PLASMA DIAGNOSTICS WITH GASEOUS LASERS J. T. Verdeyen and J. B. Gerardo (Ill. Univ.) p 529–572 refs (See N67-15241 05-25)

8. DERIVATION OF THE FREQUENCY DEPENDENT ELECTRICAL CONDUCTIVITY OF RELATIVISTIC PLASMAS M. Baus (Fonds Natl. Belge de la Rech. Sci.) and R. Balescu (Brussels Univ.) p 573–586 refs (See N67-15242 05-25)

9. ELECTROMAGNETIC WAVE PROPAGATION IN A WEAKLY IONIZED PLASMA P. Caldirola, O. De Barbieri, and C. Maroli (Milan Univ.) p 587–618 refs (See N67-15243 05-25)

10. INFLUENCE OF IONIZATION NON-EQUILIBRIUM ON WAVE PROPAGATION THROUGH PLASMA L. de Socio and L. G. Napolitano (Consiglio Nazionale delle Ricerche) p 619–641 refs (See N67-15244 05-25)

11. ACCELERATION AND REFLECTION OF PLASMA BEAMS BY MIXED STRUCTURES (HF+STATIC MAGNETIC) R. Bardet, T. Consoli, L. Dupas, R. Geller, J. Leroy, and F. Perlange (Commissariat a l'Energie Atomique) p 643–658 refs (See N67-15245 05-25)

12. ELECTRON CYCLOTRON PLASMA THRUSTOR FOR ORBIT CORRECTIVE MISSIONS H. W. Hendel and T. J. Faith, Jr. (RCA) p 659–677 refs (See N67-15246 05-25)

13. MICROWAVE POWERED PLASMA ACCELERATORS D. B. Miller (GE) p 679–698 refs (See N67-15247 05-25)

14. ELECTROMAGNETIC WAVE INTERACTION WITH ROCKET EXHAUSTS W. W. Balwanz (Naval Res. Lab.) p 699–729 refs (See N67-15248 05-07)

**N67-15235#** Royal Armament Research and Development Establishment, Fort Halstead (England).

**DIAGNOSIS OF A PLASMA BEAM EXTRACTED FROM AN ELECTRON-BOMBARDMENT ION SOURCE**

W. A. Clayden and C. V. Hurdle *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 385–418 refs (See N67-15234 05-25) CFSTI: HC $7.00/MF $1.75

A plasma beam facility has been built to study the interaction between bodies moving at high speeds in the ionosphere and the ambient charged particles. The plasma beam is extracted from an electron-bombardment ion source similar in principle to those used for ion engines. The properties of the plasma beam have been studied with various types of Langmuir probes and ion traps operating in free molecule flow. Data from these probes have been analysed to yield the distribution of ion velocity, density, speed ratio and temperature, the electron temperature and the density of slowly moving ions which result from charge exchange between ions in the beam and the neutral particles in the beam chamber. Typically the ion velocity in the beam $\simeq 2 \times 10^6$ cm/sec, the ion density $\simeq 10^8$ ions/cm$^3$ and the ion and electron temperatures $\simeq 10^5$ °K. It is shown that many of the flow conditions appropriate to a small satellite in the ionosphere are simulated when a body $\simeq 1$ cm is placed in the beam. Author

**N67-15236#** Institut fur Plasmaphysik G.m.b.H., Garching (West Germany).

**MICROWAVE INTERFEROMETER MEASUREMENTS OF THE ELECTRON DENSITY DISTRIBUTION BEHIND SHOCK FRONTS AND DISCHARGE PLASMAS**

Wassilios Makios *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 419–441 refs (See N67-15234 05-25) CFSTI: HC $7.00/MF $1.75

Measurements in which 4 mm microwaves were reflected at the shock front are reviewed, and details are given on experiments conducted to determine the electron density behind the shock front using microwave signals through the shock front. The electron densities investigated were in the range of $10^{13}$ cm$^{-3}$, while the cutoff density for 4 mm microwaves is $6 \times 10^{13}$ cm$^{-3}$. It was found that a transmission microwave interferometer with the Locher wire system vastly improved the spatial resolution over that of a conventional microwave interferometer using horns and lenses. Local measurements of the electron density and the electron collision frequency with a spatial resolution of 1/2 wavelength were obtained. M.G.J.

**N67-15237#** Naples Univ. (Italy). Inst. of Aerodynamics.

**ON THE CORRELATION OF EXPERIMENTAL DATA FOR NON-EQUILIBRIUM SEEDED PLASMA**

R. Monti *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 443–471 refs Sponsored by the Italian Comm. for Res. (See N67-15234 05-25) CFSTI: HC $7.00/MF $1.75

A more accurate theory for the evaluation of nonequilibrium electrical conductivity is based on a generalized Saha equation for two temperature plasmas. The available experimental data obtained for dc discharges through argon-potassium and argon-cesium plasmas are critically examined and compared with theoretical predictions obtained by using the above theory and by accounting for Joule heating effects on the plasma bulk temperature. In the correlation no assumptions need to be made for the values of the collision cross sections, and a single value of the energy loss

factor is assumed. The only free (i.e. adjustable) parameter is a measure of the optical transparency of the plasma, which it is plausible to consider different in different sets of experiment. It is shown, in addition, that, compared to other existing theories, the subject correlation gives a more satisfactory quantitative agreement throughout a wider range of electrical current densities. Author

**N67-15238#** Techniache Hochschule Aachen (West Germany). Physikalisches Institut.
**DETERMINATION OF TRANSPORT PROPERTIES OF A PLASMA FROM ARC MEASUREMENTS**
G. Schmitz and H. J. Patz *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 473–493 refs (See N67-15234 05-25) CFSTI: HC $7.00/MF $1.75

Various possibilities are investigated of determining semi-experimentally the transport properties of a plasma as a function of temperature and pressure from the behavior of electric arcs. Because there is a quasi-neutral thermal plasma in electric arcs, the basic equations of the single-fluid model of plasma physics for this problem are used. In the same manner as the transport properties, thermal conductivity, electrical conductivity, specific radiation, viscosity, specific enthalpy and mean mass of the atoms determine uniquely the behavior of the local and integral characteristic quantities of an arc. It must be possible on the other hand to calculate the transport properties from experimental arc data. Methods are presented, and the various procedures are applied to nitrogen and argon plasmas. Author

**N67-15239#** Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany). Institut fuer Plasmadynamik.
**IONIZATION EQUATION OF OPTICALLY THIN NON-EQUILIBRIUM PLASMAS [EQUATION D'IONISATION DE PLASMAS TRANSPARENTS EN NON EQUILIBRE]**
W. L. Bohn *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 495–515 refs In FRENCH; ENGLISH summary (See N67-15234 05-25) CFSTI: HC $7.00/MF $1.75

For optically thin nonequilibrium plasmas a generalized ionization equation is derived and discussed. With low electron densities, this equation becomes the corona formula, whereas with high electron densities it becomes the Saha equation relative to the electron temperature. Thereby, temperature and ionic charge play a major role. By means of this nonequilibrium equation the components of a helium plasma are investigated with regard to the metastable He$I$ $2^3S$ level. Furthermore, an estimate has been made of influence of the metastable level on the temperatures spectroscopically determined. Author

**N67-15240#** Imperial Coll. of Science and Technology, London (England). Plasma Physics Group.
**LASER INTERFEROMETER MEASUREMENTS OF RAPID ELECTRON DENSITY CHANGES IN A PLASMA**
C. B. Wheeler and A. E. Dangor *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 517–527 ref (See N67-15234 05-25) CFSTI: HC $7.00/MF $1.75

A He–Ne laser was constructed and used with various types of interferometer to measure plasma electron density. Particular emphasis was given to the time resolution of the interferometers since in nearly all experimental plasmas density variations take place with extreme rapidity. In a series of preliminary experiments it was found that a modified Mach–Zehnder interferometer was the fastest system; it could measure path differences about 10 times as rapidly as the corresponding Fabry–Perot arrangements. Results of density measurements using a modified Fabry–Perot system are presentedd as a function of time for a range of discharge parameters. At very high number densities the fringes disappeared. The disappearance has been shown to be due to refraction of the laser beam in the plasma due to radial electron density gradients. The long plasma length in these experiments made this a significant effort, but short lengths of uniform plasma can avoid this limitation. Author

**N67-15241#** Illinois Univ., Urbana. Gaseous Electronics Lab.
**PLASMA DIAGNOSTICS WITH GASEOUS LASERS**
J. T. Verdeyen and J. B. Gerardo *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 529–572 refs Sponsored by Army (See N67-15234 05-25) CFSTI: HC $7.00/MF $1.75

The basic principles of the three-mirror laser interferometer as applied to plasma diagnostics are reviewed. It was shown that the spherical laser interferometer is capable of nearly two orders of magnitude greater sensitivity than the plane parallel system. It was also shown that the high sensitivity of the spherical laser interferometer can be used while preserving the spatial resolution if the plasma is located in the laser cavity. The plasma changes the laser frequency and the reference cavity performs the function of a frequency sensitive reflector. Using this technique, the system has been made 27 times more sensitive than the plane–parallel case while sampling a plasma cross section of less than 1 $mm^2$. One limitation of the laser interferometer was the frequency response. However, resonances in excess of 50 per microsecond can be detected by sampling the fields in the reference modulation between the coherent laser radiation and the incoherent sidelight emitted by the gas laser system. Author

**N67-15242#** Brussels Univ. (Belgium). Faculty of Sciences.
**DERIVATION OF THE FREQUENCY DEPENDENT ELECTRICAL CONDUCTIVITY OF RELATIVISTIC PLASMAS**
M. Baus (Fonds Natl. Belge de la Rech. Sci.) and R. Balescu *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 573–586 refs (See N67-15234 05-25) CFSTI: HC $7.00/MF $1.75
(Contract AF 61(052-179)

The statistical electrodynamics of relativistic classical plasmas recently developed in the Prigogine School are used to derive a general framework for the study of material coefficients with spatial and frequency dispersion. We compute, starting from the Liouville equation, the conductivity tensor corresponding to the first order response of the plasma to an arbitrary external electromagnetic field. Next we compute the (known) Vlassov approximation of this tensor for an isotropic system. Author

**N67-15243#** Milan Univ. (Italy). Inst. of Physical Science.
**ELECTROMAGNETIC WAVE PROPAGATION IN A WEAKLY IONIZED PLASMA**
P. Caldirola, O. De Barbieri, and C. Maroli *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 587–618 refs (See N67-15234 05-25) CFSTI: HC $7.00/MF $1.75

Starting from the Boltzmann equation for the electronic distribution function and using the multiple-time-scale method, recently introduced by Frieman and Sandri, it is possible to obtain a set of equations which describe the interaction processes between an electromagnetic field and a weakly ionized magneto-plasma. Using this technique the expressions of the electronic distribution function and of the complex dielectric permittivity tensor are explicitly calculated. Author

**N67-15244#** Consiglio Nazionale delle Ricerche, Rome (Italy). Impresa Trasformazione Energia e Proprieta' dei Materiali.
**INFLUENCE OF IONIZATION NON-EQUILIBRIUM ON WAVE PROPAGATION THROUGH PLASMA**

L. de Socio and L. G. Napolitano *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 619-641 refs (See N67-15234 05-25) CFSTI: HC$7.00/MF$1.75

The propagation characteristics for plane magneto-fluid-dynamic waves of small amplitude are dealt with in media of finite electrical conductivity, taking into account a finite ionization rate. The model describing the plasma is that for an inviscid mixture with variable ionization degree and negligible thermal conductivity, viscosity and diffusion effects. The general dispersion equation for any relative orientations of the external magnetic field $B_0$ and the wave vector $\lambda$ is given. For $B_0 \| \lambda$ already known transverse waves of Alfvénic type and longitudinal waves completely analogous to the purely acoustic waves in a reacting mixture are found. The case $B_0 \perp \lambda$ (longitudinal waves) presents instead new features. Phase velocity and the absorption per unit length are given either in exact form or by a suitable linearization procedure. The influence and the relative importance of the chemical and electrical dissipation on the wave characteristics are discussed. Author

**N67-15245#** Commissariat a l'Energie Atomique, Saclay (France). Services de Physique Appliquée.

**ACCELERATION AND REFLECTION OF PLASMA BEAMS BY MIXED STRUCTURES (HF+STATIC MAGNETIC) [ACCELERATION ET REFLEXION DE FAISCEAUX DE PLASMA PAR DES STRUCTURES MIXTES (HF+MAGNETIQUE STATIQUE]**

R. Bardet, T. Consoli, L. Dupas, R. Geller, J. Leroy et al *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 643-658 refs In FRENCH; ENGLISH summary (See N67-15234 05-25) CFSTI: HC$7.00/MF$1.75

Reference is made to the basic principle and the mechanism of the production and reflection of plasma jets. Two types of accelerators are described in particular, measurement methods used are discussed, and experimental results are given. The apparatus described functions either with a steady HF field produced by an S band, 500 W d.c. generator, or with a dampened traveling wave HF field, with right circular polarisation, produced by an X band, 300 W d.c. generator. Fluxes of $2 \times 10^{17}$ ions/cm$^2$/sec argon, 1.2 keV has been obtained with the first type of equipment, for $10^{18}$ ions of 200 eV argon with the second; beam diameters were respectively 3 cm and 4 mm. In accumulation conditions, the density accumulated in the case of the second apparatus reached the cutting density. The gas yield is more than 30% and the HF energy produced is of the order of 60% (no allowance being made for losses in the guides, window, or insulator). A theoretical investigation of the interaction between two plasma beams produced by such structures would seem to indicate that accumulated plasma is not affected by dual beam instabilities. Author

**N67-15247#** General Electric Co., Philadelphia, Pa.

**MICROWAVE POWERED PLASMA ACCELERATORS**

David B. Miller *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 679-698 refs (See N67-15234 05-25) CFSTI: HC$7.00/MF$1.75

Steady state plasma accelerators powered by microwave frequency electric fields are shown to operate efficiently under high power, steady state conditions. Details of the experimental studies on a group of microwave driven plasma accelerators are presented. Radio frequency probing indicated that under the most efficient conditions, the majority of the interaction occurs in a narrow region out beyond the accelerator exit. Author

**N67-15269#** Naval Research Lab., Washington, D. C.

**NEUTRON PRODUCTION BY FUSION IN A CLASS OF ANISOTROPIC PLASMAS Final Report**

James B. Langworthy 30 Jun. 1966 57 p refs

(ARPA Order 306-62; Grant NSF GP-3217)

(NRL-6391; AD-639658) CFSTI: HC $3.00/MF $0.50

The neutron production rate of a fusion reaction in a plasma of deuterium is calculated by a non-Maxwellian average, assuming the differential cross section is known. For the average it is assumed the ion velocity distribution of one plasma component is that of a beam and that of the other component is a Maxwell distribution. It is found that cross section anisotropy has no effect on neutron production rate or on the excitation function. An expression is obtained which contains the detailed effects of anisotropy on neutron speed and angle distributions. Prominent behavior of this expression is discussed. For purposes of numerical calculation, a Gamow form is assumed for the total cross section. Neutron production rate results are presented in a contour plot as a function of beam energy and plasma temperature over ranges of the parameters of most interest in thermonuclear research. Prominent behavior here is understood in the light of two well known subcases of this calculation: (1) neutron production by bombarding a cold target and (2) neutron production from a Maxwellian plasma. A qualitative analysis with order of magnitude estimates is made to consider the practical implications of the use of the assumed nonequilibrium distribution. It is shown that the assumed distribution may exist for small observation volumes and for short observation times in plasma regimes of thermonuclear interest. It is a general result of this analysis that an arbitrary plasma cannot be shown isotropic except by fine time resolution technique. Author (TAB)

**N67-15275#** Michigan Univ., Ann Arbor. Dept. of Physics.

**PLASMAS OF MERCURY IN A PRESSURE-DRIVEN SHOCK TUBE Final Report**

Otto Laporte Sep. 1966 10 p

(Grant AF-AFOSR-934-65)

(AFOSR-66-1939; AD-640245) CFSTI: HC $1.00/MF $0.50

A pressure driven shock tube to produce shock waves in mercury vapor was constructed and is described and figured in the report. In order to have sufficient mercury density it is necessary to heat the entire tube to 400C. It is intended to make spectroscopic studies of the essential lines of mercury, especially the 2537A line as emitted by the shock heated vapor. It is expected that the actual measurement phase of the project will commence during the coming year. Author (TAB)

**N67-15291#** RCA Victor Co., Ltd., Montreal (Quebec). Research Labs.

**REFLECTION OF CIRCULARLY POLARIZED ELECTROMAGNETIC WAVES FROM AN ANISOTROPIC PLASMA**

Morrel P. Bachynski, Brian W. Gibbs, and Kurt A. Graf Jul. 1966 40 p refs

(Contract AF 19(628)-4071)

(SR-4; RCA Res. Rept.-7-801-51; AFCRL-66-680; AD-642123) CFSTI: HC $3.00/MF $0.65

The reflection of both right-hand and left-hand circularly polarized plane electromagnetic waves, normally incident along the direction of an imposed static magnetic field in an anisotropic plasma, was investigated. Detailed measurements at a frequency of 9.2 gc of the intensity and phase of the wave reflected from a helium afterglow plasma over wide ranges of plasma frequency and electron cyclotron frequency were carried out. The measured reflected power varied from less than one percent of the incident power to complete reflection and large undulations in both intensity and phase of the reflected wave with changing electron density and magnetic field were observed. Comparison with theory based on a simple sharply bounded uniform plasma slab shows good agreement for the general nature of the dependence of the reflected wave on the plasma properties. The exact electron densities corresponding to the maxima and minima and the absolute values of the intensity and phase of the reflected wave are not accurately predicted by this simple theoretical model. In the

region of the electron cyclotron frequency, for an incident right-hand circularly polarized wave, the reflected signal undergoes a reduced variation in phase and the intensity after attaining a maximum is observed to decrease with increasing electron density. Author (TAB)

N67-15299*# Michigan Univ., Ann Arbor. Electron Physics Lab.
**NONLINEAR ELECTROMAGNETIC WAVE PROPAGATION IN A MAGNETOACTIVE FINITE TEMPERATURE PLASMA**
H. C. Hsieh and J. E. Rowe Sep. 1966 55 p refs
(Grant NsG-696)
(NASA-CR-81149; 1-94) CFSTI: HC $3.00/MF $0.65 CSCL 20I

A system of ordinary nonlinear differential equations, governing the scalar and vector potentials associated with a one-dimensional electromagnetic wave in a hot plasma, has been derived using a stationary solution of the nonlinear Boltzmann–Vlasov equation in a moving reference frame. Three cases are considered: no applied static electromagnetic field, a static magnetic field in the direction of wave propagation, and static electric and magnetic fields in the direction of propagation. In the static field-free case, the derived dispersion relation indicates that the wavelength of the transverse electromagnetic wave is amplitude dependent. In the second case, the transverse electromagnetic wave appears as a circularly polarized sinusoidal wave in a laboratory frame of reference. In the third case, the transverse electromagnetic wave appears as an elliptically polarized plane wave in the laboratory frame. The effect of the static electric field on the wavelength and the Faraday rotation is investigated. Author

N67-15318# Johns Hopkins Univ., Baltimore, Md. Dept. of Physics.
**STARK BROADENING OF AI AND AII LINES AT HIGH ELECTRON CONCENTRATIONS**
W. Richard Powell and Donald E. Kerr Apr. 1966 100 p refs
(Contract Nonr-4010(10))
(TR-3; AD-639756) CFSTI: HC $3.00/MF $0.75

Stark-broadened profiles for several AI and AII lines were measured. These results were compared with Griems theoretical predictions. The shifts and widths observed for AI lines were less than predicted, but the difference did not exceed the combined theoretical and experimental uncertainties. However, the profiles observed were less symmetric than those predicted. A highly reproducible transient plasma generator was developed for this study. The characteristics of this source were investigated to some extent and the homogeneity along the line of sight was investigated in detail. The temperature of the plasma was determined from measurements of the absolute intensities of spectral lines of AI and AII. For calculation of this temperature, a single noniterative equation was derived. The range of validity of this equation was explored. Electron concentrations were also derived from measurements of absolute intensities. Some comments with regard to current argon transition probabilities are made. Author (TAB)

# 26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N67-14467*# Max-Planck-Institut fur Metallforschung, Stuttgart (West Germany).
**PLASTIC DEFORMATION AND IMPERFECTIONS IN CRYSTALS (SUMMARY OF LECTURE)**
Alfred Seeger *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 99–102 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

Crystal dislocation, in relation to plastic deformation and crystal imperfections is briefly outlined. X-ray studies and crystal structure investigations are reviewed in the light of the concept of work-hardening of metals. R.LI.

N67-14622*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**MICROWAVE SPECTROSCOPY**
James M. Andrews, Jr. *In its* Res. Lab. of Electron. 15 Oct. 1966 p 1–6 ref (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25
(Contract DA-36-039-AMC-03200(E))

The low-temperature ultrasonic reflection coefficients of thin film were studied to determine the electronic contribution to the ultrasonic attenuation coefficient at 9 GHz. Thin films between 1.2 $\mu$ and 3.6 $\mu$ thickness were deposited onto the end of an x-cut quartz rod. The opposite end of the rod was excited piezoelectrically by means of an X band re-entrant cavity. Ultrasonic echo pulses reflected from the tin film back to the cavity were monitored as the film was switched between the superconducting and normal states by means of an external magnetic field. Theory, equations, and experimental results are presented. The obtained values suggest that some number between 2 and 3 electrons per atom in metallic tin is effective in the electronic contribution to ultrasonic attenuation. K.W.

N67-14625*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**OPTICAL AND INFRARED SPECTROSCOPY**
C. H. Perry, E. F. Young, and T. F. Mc Nelly *In its* Res. Lab. of Electron. 15 Oct. 1966 p 17–29 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25
(Contracts DA-36-039-AMC-03200(E); AD 19(628)-395)

In the first of two studies, the transmission spectra of thin single crystals ($\approx$70$\mu$) of $KMgF_3$, $KMnF_3$, $KCoF_3$, $KNiF_3$, $KZnF_3$, $RbMnF_3$, and K(50% Mg+50% Ni)$F_3$ were viewed from 4000 $cm^{-1}$ to 20 $cm^{-1}$ at 300°K and 85°K with the use of unpolarized radiation. The absorption bands found in this transmission study and those found in a previous reflectance spectra study of the same materials were assigned to multiphonon processes occurring at the edge of the Brillouin zone. A fitting scheme was proposed and the frequencies of the nine phonon branches at the edge of the zone were determined for this list of fluoride perovskites. In the second study, far infrared reflectance measurements were made on single crystals $KTaO_3$ from 40 to 1000$\mu$ (250–10 $cm^{-1}$) over the temperature range 12° to 463°K. The reflectance data were analyzed using a Kramers–Kronig method to obtain total conductivity from the imaginary part of the dielectric constant. The conductivity exhibits a very strong temperature dependent low-frequency peak and accounts for more than 90% of the static dielectric constant. K.W.

N67-14663# Illinois Univ., Urbana. Dept. of Chemistry and Chemical Engineering.
**MAGNETIC PROPERTIES AND ELECTRONIC STRUCTURE ON LANTHANUM HYDRIDES**
William G. Bos (Louisville Univ.) and H. S. Gutowsky 6 Sep. 1966 14 p refs Presented at 18th Southeastern Regional Meeting of the Am. Chem. Soc., Louisville, Ky., Oct. 1966 Submitted for Publication
(Contract Nonr-1834(13))
(TR-93; AD-640514) CFSTI: HC $1.00/MF $0.50

Previously the nuclear magnetic properties of the lanthanum hydrides have been interpreted in terms of a protonic model while the bulk susceptibilities have been attributed to an hydridic structure. The experimental results and their theoretical relation to the electronic structure are discussed. A simple band model is used to show that the hydridic structure also can account for the magnetic resonance results. Application of the band model to other metallic hydrides is considered briefly. Author (TAB)

N67-14699# Michigan State Univ., East Lansing. Dept. of Physics
**STUDY OF INTERACTIONS BETWEEN F-SHELL TRANSITION IONS IN NON-METALLIC CRYSTALS Annual Technical Progress Report, 1 Oct. 1965–15 Jun. 1966**
20 Jun. 1966 12 p refs
(Contract AT(11-1)-1533)
(COO-1533-2) CFSTI: HC $1.00/MF $0.50

Several rare earth chlorides were investigated by nuclear magnetic and quadrupole resonance techniques. In $GdCl_3$, three Zeeman components of the pure quadrupole resonance line were observed for $^{35}Cl$ and $^{37}Cl$ below Curie temperature. These data were analyzed, giving for the electric field gradient asymmetry parameter $\eta = 0.425$; results are tabulated for internal magnetic field vs temperature. A crystal of $PrCl_3$ was studied in a $^3He$ bath at temperatures down to about 0.5°K. At the lowest temperature reached, the pure quadrupole line at 4.567 Mc was observed to split into two lines. A single crystal of $NdCl_3$ was studied down to about 0.5°K. Near the lowest temperature reached, the signal grew weak and disappeared. No splitting was observed. A sample of fifty-fifty mixture of $NdCl_3$ and $PrCl_3$ was examined by NMR at 77°K. No 35Cl resonance was found, particularly at the frequencies expected for resonance in pure $NdCl_3$ and $PrCl_3$. NSA

N67-14759# Oregon State Univ., Corvallis. Dept. of Chemistry.
**THE OSCILLATOR STRENGTH OF LEAD (II) ION IN POTASSIUM CHLORIDE SINGLE CRYSTALS**
Robert E. Holmes and Allen B. Scott 25 Aug. 1966 36 p refs
(Contract Nonr-1286(05))
(TR-9; AD-640171) CFSTI: HC $2.00/MF $0.50

KCl single crystals, homogeneously doped with PbCl2, were analyzed for lead by the dithizone method, and the optical absorbance at 273 millimicrons was determined. The absorbance at 273 millimicrons in samples of a given lead concentration depended on original purity of the KCl, the atmosphere under which the crystal was grown, and the thermal treatment prior to measurement. The oscillator strength was found to be 0.11 plus or minus 0.02 in crystals of highest purity, grown under dry HCl or argon, and rapidly quenched from 600C. This agrees with the value reported by Sibley, Sonder, and Butler. When reagent grade KCl was used, or the atmosphere was air, the average oscillator strength found was 0.086, which is close to the value reported by Kailu. Author (TAB)

N67-14947# Delaware Univ., Newark. Dept. of Physics
**TIME PERIODIC SOLUTIONS OF TRANSPORT-EQUATIONS AND POISSON-EQUATIONS FOR LAYERLIKE FIELD INHOMOGENEITIES**
K. W. Boer and G. A. Dussel Oct. 1966 45 p refs
(Grant Nonr(G)-4336(00))
(TR-14; AD-641390) CFSTI: HC $2.00/MF $0.50

Time dependent solutions of the Poisson and transport equations containing drift and diffusion for the case of layerlike flat inhomogeneities propagating underformed and with constant velocity through a crystal, are discussed in terms of an analysis of their projections in the n-E plane. Two principal models are discussed: one for a trap controlled cyrstal (CdS type), and the other for a trap-free crystal (GaAs type, Gunn effect) for field dependent recombination or field dependent mobility. It is found that, in addition to the triangular domains, periodic propagating solutions can exist. Conditions on the value of the layer velocity and the current are derived. Author (TAB)

N67-14949# Wisconsin Univ., Madison.
**CYCLOTRON RESONANCE EXPERIMENTS Final Report, 1 Apr. 1963–31 Mar. 1966**
Richard N. Dexter, Paul S. Pearcy, Francis F. Huppe, Philip L. Radoff, Boyd Veal et al Wright-Patterson AFB, Ohio, ARL, Apr. 1966 19 p refs
(Contract AF 33(657)-11515)
(ARL-66-0078; AD-639395) CFSTI: HC $1.00/MF $0.50

Various experiments including cyclotron resonance, helicon propagation and de Haas - van Alphen effect were conducted for purposes of studying transport properties of several semiconductors and semimetals. These materials include Alpha-Sn, Te, InSb, Sb, CdS and HgTe. In most cases it was possible to obtain new information on effective masses, carrier densities or scattering times. Instrumentation which was constructed to permit the use of large uniaxial stress in cyclotron resonance and de Haas - van Alphen experiments is described along with a discussion of the more successful research areas. Author (TAB)

N67-14951# Lewis (E. B.) Co., Inc., East Hartford, Conn.
**PRODUCTION ENGINEERING MEASURE, CRYSTAL UNIT CR-(XM-66)/U Quarterly Report, 16 Feb.–16 May 1966**
Thomas F. Davis 16 May 1966 34 p
(Contract DA-36-039-AMC-06180(E))
(QR-1; AD-642148) CFSTI: HC $3.00/MF $0.65

A study was made to carry out the production engineering necessary for the manufacture of quartz crystals for filter applications operating on the fifth overtone in the frequency range of 70 to 100 mc/s in accordance with signal corps specification SCS-243 dated 21 April 1965. Design data and fabrication technique for at-cut quartz crystals, 70 mc/s fifth overtone for filter application is presented. An evaluation of crystal units with various plate backs vs. mode suppression is given. TAB

N67-15003# Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy.
**ON THE THERMODYNAMIC PROPERTIES OF SEVERAL SOLID PHASES OF THE COMPOUND INSB**
A. K. Jena, M. B. Bever, and M. D. Banus 24 Oct. 1966 24 p refs
(Contract Nonr-3963(19))
(TR-1; AD-642147) CFSTI: HC $3.00/MF $0.65

Measurements of the heat effects on addition of various solid phases of INSB to a solution calorimeter confirmed the existence of a new high-pressure phase INSB(III), which was formed at 37 KBAR and 623K. The heats of formation of INSB(I), INSB(II) and INSB(III) were measured and the heats of transformation of INSB(I) to INSB(II) and INSB(III) and of INSB(II) to INSB(III) at atmospheric pressure and 78K were determined independently. Other thermodynamic properties of these phases, the phase boundary INSB(I)/INSB(II) and the relative positions of the triple points were calculated. The pressure-volume term is shown to be more critical than the internal energy difference in making the phase INSB(I) less stable than INSB(II) at high pressures. Observations on partially transformed specimens suggest that the transformation of metastable INSB(III) takes place in the two steps INSB(III) to INSB(II) and INSB(II) to INSB(I). Author (TAB)

N67-15017# McGill Univ., Montreal (Quebec). Eaton Electronics Research Lab.
**FINE STRUCTURE IN THE ABSORPTION SPECTRA OF $KMnF_3$ AND $RbMnF_3$**
Richard Stevenson Oct. 1966 15 p refs
(Contract Nonr-3013(00))
(TR-4; AD-641915) CFSTI: HC$1.00/MF$0.50

Experimental studies of the absorption spectra in the 3900A region of KMnF3 and RbMnF3 at 4.2K are presented. The spectra of the two substances are almost identical, and show the same number of lines and type of fine structure. The quadruplet-gamma-3 levels, split by the tetragonal component of the crystalline field, are associated with observed transitions at approx. 3939A and 3896A. Definite energy level patterns are found for the weak vibrational lines accompanying these transitions. A sharp and very weak magnetic dipole line M is found (with three components) at approx. 3978A. An electric dipole line P1 at approx. 3966A appears to be a magnon sideband of the magnetic dipole line. M is presumed to be an exciton line associated with the electric dipole transition P2 at approx. 3955A to the main quadruplet-gamma-1 level. The electric dipole lines P1 and P2, associated with the quadruplet-gamma-1 level, show a fine structure which is interpreted in terms of exchange coupled pairs of ions with a Spin hamiltonian-2JS1S2. The selection rule for these transitions is that the total spin of the pair is conserved. Author (TAB)

N67-15029# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ELECTRICAL CONDUCTIVITY AND WIDTH OF FORBIDDEN ZONE OF SOLID SOLUTIONS OF SEMICONDUCTOR COMPOUNDS OF INDIUM PHOSPHIDE AND GALLIUM ARSENIDE**
N. N. Sirota and L. A. Maksvetskaya 25 Apr. 1966 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Belorussk. SSR (Minsk), v. 8, no. 10, 1964 p 632-633
(FTD-TT-65-1899; TT-66-62440; AD-640303) CFSTI: HC $1.00/MF$0.50

A study was undertaken of the temperature dependence of the electrical conductivity of the alloys of the system INP-GAAS in the range of temperature of 170 to 750 C and a determination was made of the energy of activation or width of the forbidden zone in accordance the temperature change of the electrical conductivity in the area of natural conductivity. TAB

N67-15031# Midwest Research Inst., Kansas City, Mo.
**THE EFFECT OF OXIDE FILMS ON DISLOCATION-SURFACE INTERACTIONS IN ALUMINUM Technical Report, 15 Aug. 1965-14 Aug. 1966**
J. C. Grosskreutz and C. Q. Bowles 14 Aug. 1966 35 p refs
(Contract Nonr-3908(00))
(AD-640280) CFSTI: HC$2.00/MF$0.50

Aluminum single crystals were deformed in cyclic strain, both in air and in vacuum, and with both 50 and 100 A thick oxide films on the surface. The results show that deformation in vacuum produces a layer of edge dislocation dipoles trapped just beneath the surface as well as reducing the amount of surface slip. The effect of increasing the oxide coating thickness is to reduce the amount of slip observable on the surface of the oxide. As an aid in interpretation, the mechanical properties of thin, amorphous aluminum oxide films were measured in air and in vacuum. Youngs modulus, E sub c, was found to increase by a factor of 4 under vacuum, and the fracture strength by a factor of 1.5. These increases are most likely due to the removal of absorbed water vapor. The increase in E sub c can account for the presence of the trapped dislocation dipoles under vacuum by using the theory of Head and Conners which predicts a net repulsive force on near-surface dislocations when the modulus of the coating is greater than the modulus of the substrate. The reduction in surface slip observed under vacuum is due to the increase in both E sub c and the strength properties of the oxide coating. Author (TAB)

N67-15074# Illinois Univ., Urbana. Dept. of Electrical Engineering.
**JUNCTION EFFECTS IN COMPOUND SEMICONDUCTORS Status Report No. 6**
N. Holonyak, Jr., M. D. Sirkis, M. R. Johnson, J. S. Moore, and G. Stillman Jun. 1966 12 p refs
(Contract AF 19(628)-4337)
(AFCRL-66-617; AD-642342) CFSTI: HC$3.00/MF$0.65

The effect of the considerable depth of donor impurity states near the indirect <100> conduction band minima on the direct-indirect transition in Ga(AsP) is discussed. A simple technique for using a Ga(As-P) laser to operate a CdSe laser is described. The current understanding of the P-'I'-N deep-level oscillator is mentioned. Author (TAB)

N67-15086# McGill Univ., Montreal (Quebec). Eaton Electronics Research Lab.
**HIGH-FIELD ZEEMAN EFFECT MEASUREMENTS USING A SCANNING TECHNIQUE AND PULSED FIELDS**
I. Maartense Oct. 1966 16 p refs
(Contract Nonr-3013(00))
(TR-5; AD-641916) CFSTI: HC$1.00/MF$0.50

A method is described for obtaining optical spectra of solids subjected to short duration pulsed magnetic fields of the order of 300 kilo-oersteds. A spectral region is scanned repetitively every 28 microsec by a moving slit and detected photoelectrically, making it possible to measure wavelength and intensity changes of spectral features as a function of magnetic field. Provision is made for cooling the sample to liquid helium temperature. The Zeeman effect of the septuplet-F-0 to quintuplet-D-2 transition of Eu(3+) in Europium tungstate is used as a demonstration of the technique. Author (TAB)

N67-15100# Washington State Univ., Pullman. Dept. of Physics.
**INTERACTIONS OF ACTIVATED GASES WITH SOLIDS Final Scientific Report, 1 Oct. 1961-Jun. 1966**
Edward E. Donaldson Nov. 1966 9 p refs
(Grants AF-AFOSR-551-64; AF-AFOSR-62-86)
(AFOSR-66-2673; AD-642408) CFSTI: HC$3.00/MF$0.65

In investigations of the adsorption of nitrogen on solid surfaces, it was shown that when nitrogen molecules are either bombarded by electrons or when they encounter an incandescent metal surface, atoms of nitrogen may be produced which sorb much more readily than the parent molecule. Thus the activated state was shown to be atomic. Burial of argon ions in nickel was studied. It was learned that the sticking probability for these ions depends upon whether the nickel surface is in a cold-worked or an annealed condition (highest sticking probability in the case of cold-worked nickel). This suggests that either grain boundaries or dislocations may provide sites for adsorption but neither possibility can yet be eliminated. Desorption by photons, electrons and ions was observed. Photon and electron bombardment desorption studies demonstrated that desorption occurs by way of an intermediate activated surface state while ion bombardment desorption was observed only as a secondary process in ion burial studies. Desorption by thermal means permitted the determination of energy with which ions are bound in the metal. Author (TAB)

N67-15274# Royal Inst. of Tech., Stockholm (Sweden). Microwave Dept.
**PLASMA OSCILLATIONS IN SOLIDS Final Scientific Report, 1 May 1965-31 May 1966**

Bertil Agdur 31 May 1966 12 p
(Contract AF 61(052)-888)
(AFCRL-66-685; AD-640467) CFSTI: HC $1.00/MF $0.50

A discussion of work under the present contract is given. Among the problems treated are non-linear plasma wave interaction, dispersion properties and amplification of plasma waves in solids, amplification of optical phonons, amplification of acoustic phonons under non-isothermal conditions, properties of ionization waves in solids. Author (TAB)

N67-15277# Naval Radiological Defense Lab., San Francisco, Calif.
**PRELIMINARY INVESTIGATION OF THE STRUCTURAL PROPERTIES OF LITHIUM FLUORIDE SINGLE CRYSTALS**
Lewis D. Miller 6 Sep. 1966 34 p refs
(USNRDL-TR-1067; AD-640317) CFSTI: HC $2.00/MF $0.50

The purpose of the report is to describe the initial work performed in establishing a correlation between the solid state structure of lithium fluoride, and the thermoluminescence produced by interaction with ionizing radiation. Single crystals of lithium fluoride were grown, containing large concentrations of magnesium, in an attempt to determine the effects of this activator on the kinetics of thermoluminescence. The method of crystal growth and subsequent analysis of the crystals produced are discussed. Because F-centers in lithium fluoride have been extensively investigated it was felt useful to look at the methods of producing this center. The production of F-centers by means of x rays and by ultra-violet light of short wave-length is described. Light sources for producing ultra-violet light is also discussed. Finally, the instrumentation produced for this study together with future plans are discussed. Author (TAB)

N67-15278*# Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering.
**PHOTOVOLTAIC EFFECTS IN CADMIUM TELLURIDE-MERCURY TELLURIDE HETEROSTRUCTURES**
George Stanley Almasi (Ph.D. Thesis) 1 Nov. 1966 131 p refs
(Grant NsG-498)
(NASA-CR-81144; SR-2) CFSTI: HC $3.00/MF $1.95 CSCL 20L

Measurements made on photovoltaic devices by the interdiffusion of CdTe and HgTe are reported. It is found that the devices display rectification and possess a spectral response which decreases exponentially with decreasing energy from a maximum at the energy corresponding to the CdTe bandgap. The theoretical model developed to account for this behavior involves a sandwich of constant energy gap material and graded gap material, with a p-n junction in the constant-gap material immediately adjacent to the graded region. The exponent of the spectral response is then found to reflect the band-edge variation of the carrier species being collected by the junction. Because the spectral bandwidth is so narrow, these devices offer no improvement over present photovoltaic energy converters. To improve their performance as photodetectors, a more precise control of the equilibrium carrier concentrations must be developed. Author

N67-15294# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**RADIATION PHENOMENA IN ION CRYSTALS**
K. Shvarts 16 Apr. 1966 18 p refs Transl. into ENGLISH from Latvijas PSR Zinatnu Akad. Vestis (RIGA), no. 4, 1964 p 30-37
(FTD-TT-65-1734; TT-66-62421; AD-640287) CFSTI: HC $1.00/MF $0.50

Research at the Physics Institute of the Latvian Academy of Sciences in the following areas is summarized: (1) energy transmission processes for basic substance to impurity and structural defects; (2) electric charge transmission processes in crystals; (3) microstructure of impurity centers and its change under the effect of radiation; (4) energy accumulation processes and creation of radiation defects. Author (TAB)

N67-15301# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THERMOELECTRIC PROPERTIES OF THE SYSTEM $CuSbTe_2$-SnTe**
R. Kh. Nina, Ya. I. Nasirov, and T. G. Osmanov 25 Apr. 1966 10 p refs Transl. into ENGLISH from Izv. Akad. Nauk Azerb. SSR, Ser. Fiz. Mat. i Tekhn. Nauk (Baku), no. 5, 1964 p 69-72
(FTD-TT-65-1993; TT-66-62444; AD-640309) CFSTI: HC $1.00/MF $0.50

In a study of effective materials suitable for making thermal elements in different temperature areas, the $CuSbTe_2$-SnTe system was investigated. The presence of a continuous series of solid solutions is mentioned, and tabular data list the values of the thermo-emf, electrical conductivity, heat conductivity, concentration, and mobility of the current carrier at room temperature for the system investigated. The form of the Lorentz number for the degenerate and non-degenerate electron gas is also given. R.U.

N67-15323# Naval Research Lab., Washington, D. C.
**THE RESIDUAL RESISTANCE RATIO OF PURE IRON Final Report**
A. I. Schindler and B. C. La Roy 23 Aug. 1966 8 p refs
(ARPA Order 418)
(NRL-6395; AD-640068) CFSTI: HC $1.00/MF $0.50

The resistance at zero magnetic induction of iron specimens of varying impurity content was determined by extrapolating the longitudinal magnetoresistance data taken at magnetic fields above saturation. Such resistance values may then be used to determine a modified residual resistance ratio (RRR), which is shown to be a more appropriate index of purity for ferromagnetic metals than that obtained with resistances measured in zero applied magnetic field. Author (TAB)

N67-15326# Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy.
**THE ROLE OF SURFACE TREATMENT IN THE FIELD EFFECT ANOMALY OF N-TYPE InSb AT HIGH MAGNETIC FIELDS**
Shinji Kawaji and Harry C. Gatos Aug. 1966 14 p refs
(Contract Nonr-3963(05))
(TR-6; AD-639650) CFSTI: HC $1.00/MF $0.50

By applying a magnetic field perpendicular to the surface of n-type InSb during a classical field effect experiment, a decrease in surface conductance was observed as contrasted to the expected field effect increase in conductance. This anomaly in the field effect was found in the case of cleaved $111\bar{8}$ as well as etched $111\bar{8}$ surfaces at 77K both in vacuum or immersed in liquid nitrogen. In the case of the $1\bar{1}08$ surfaces the anomaly was also observed at 4.2K in vacuum but not when they were immersed in liquid helium. The anomaly was not present at 4.2K in the case of $111\bar{8}$ surfaces either in vacuum or when they were immersed in liquid helium. The results are explained on the basis of cross quantization of the kinetic energy of the electrons by the narrow surface space charge potential barrier normal to the surface and the magnetic orbital quantization on a plane parallel to the surface. (The symbol $\bar{8}$ is used here to indicate brackets). Author (TAB)

# 27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N67-14500*# Polytechnic Inst. of Brooklyn, N. Y.
**GRAVITATIONAL STRESSES IN A CYLINDRICAL, ORTHOTROPIC, VISCOELASTIC SOLID PROPELLANT GRAIN**
Jerome M. Klosner and Mahmoud Sadre *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 301–320 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00
(Contract Nonr-839(32))

The quasi-static analysis of a long, circular, orthotropic, viscoelastic, cylindrical solid propellant grain supported rigidly at its outer surface and subjected to gravitational stresses acting perpendicular to its longitudinal axis is presented. The solution is obtained by use of a generalized Laplace transform and the inversion integral is evaluated for short and very long times. An exponential form is then used to obtain results for the complete time range. A comparison is made between the orthotropic viscoelastic, orthotropic elastic and the isotropic elastic solutions of the same problem for three shell thicknesses. Author

N67-14915*# Melpar, Inc., Falls Church, Va.
**HAZARDS MONITORING AT NASA MERRITT ISLAND LAUNCH AREA. VOLUME I, TASK A: SENSOR SELECTION AND LOCATION FOR APOLLO FUEL TRANSFER AND TANKING SYSTEM**
Nov. 1965 60 p
(Contract NAS10-2009)
(NASA-CR-80954) CFSTI: HC $3.00/MF $1.30 CSCL 21I

The monitoring of flow in hypergolic and cryogenic fuel and oxidizer systems is discussed, and a detailed analysis of fuel and oxidizer flow from drawing set 75M14574 (tables of these fuel and oxidizer sets are given) served as a basis for selecting hazards monitoring sensors and for recommending suitable monitoring locations. Specific recommendations of areas, levels, locations, and sensor types are presented in other tables for 1) hypergolic fuel vapor lines, 2) hypergolic oxidizer vapor lines, 3) nitrogen tetroxide lines, 4) monomethylhydrazine lines, 5) aerozine-50, 6) liquid oxygen lines, and 7) liquid hydrogen lines. L.S.

N67-14871# Air Force Systems Command, Wright-Patterson AFB, Ohio. Aero Propulsion Lab.
**HYDROCARBON FUELS FOR HYPERSONIC VEHICLES**
Herbert R. Lander, Jr. and Alan E. Zangel [1966] 30 p refs Presented at the 13th Ann. AF Sci. and Eng. Symp., Arnold AF Station, Tenn., 27–29 Sep. 1966
(AFAPL-CONF-67-3; AD-642764) CFSTI: HC $3.00/MF $0.65

The incentive of using fuels with greater density and better handling characteristics than hydrogen is important. Hydrocarbons have limited cooling capability; but additional heat sink capacity may be realized by allowing the hydrocarbon fuel to undergo a phase change, thus absorbing the latent heat of vaporization, and then allowing the gaseous fuel to react endothermically and to form combustible products. Endothermic reaction requires heat addition and the reaction products furnish additional cooling by absorbing sensible heat. Endothermic reactions can be classified as either thermal or catalytic. Thermal reactions are simplest in application, but have the two disadvantages of low reaction rates at temperatures below 1200F and of relatively low heats of reaction in comparison to catalytic reactions. For this reason, the catalytic endothermic reaction has received the most effort. Catalytic studies thus far have shown that the group of hydrocarbons with the greatest reactivity are the naphthenes. Laboratory investigations have indicated that the methylcyclohexane (mch)/platinum on alumina system has a total heat sink capacity of approximately 2000 British thermal units (btu)/platinum on alumina system has a total heat sink capacity of approximately 2000 British thermal units (btu)/pound of fuel at 1350F at a volumetric flow rate of 100 cubic feet/hour or fuel/cubic foot of catalyst and at a pressure of 10 atmospheres. Author (TAB)

# 28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N67-14652# General Electric Co., Cincinnati, Ohio. Flight Propulsion Div.
**HIGH-SPEED WIND TUNNEL TESTS OF A HIGH BYPASS LIFT/CRUISE FAN PROPULSION SYSTEM Final Report, May 1963–Jan. 1966**
Eugene G. Smith Jul. 1966 778 p refs
(Contract DA-44-177-AMC-10(T))
(R66FPD161; USAAVLABS-TR-66-40; AD-639982) CFSTI: HC $10.80/MF $3.00

An investigation was carried out to determine the aerothermodynamic characteristics of a family of close-coupled lift/cruise fan installations. The lift/cruise installation consisted of the General Electric X376 tip turbine fan system driven by a T58-6A core engine acting as a gas producer, and a nacelle system comprised of a family of interchangeable inlet and exhaust systems. The characteristics were obtained for Mach numbers between 0.0 and 0.85. The test results showed that the low-speed drag coefficient of the nacelle system (including core engine) was between 0.04 and 0.08, depending on the nacelle geometry and the inlet mass flow ratio. Drag rise or drag divergence occurred at lower than predicted test Mach numbers because of premature critical flow in the region of a nacelle fairing between fan and engine. The axisymmetric regions of the fan nacelle and the core engine nacelle demonstrated critical Mach number performance as obtained using standard nacelle design procedures. The test results provide criteria for redesign of the fairing regions to eliminate the premature critical flow conditions in this region of the installation. Analysis and recommendations for fairing and inlet lip design changes are provided; small scale unpowered model tests would be needed to verify the analysis. Author (TAB)

N67-14790*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**HEAT STERILIZATION OF PYROTECHNICS AND ONBOARD PROPULSION SUBSYSTEMS**
Winston Gin et al *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 433–458 refs (See N67-14781 05-05)
GPO: HC $2.25; CFSTI: MF $2.50

Progress is reported on the development of a hot bridge wire squib initiator. Results of tests on the power switching and pyrotechnic control circuitry used in the Mariner Mars and Ranger Block III spacecraft show no serious degradation of electric components and functions. Technology required for a sterilizable

sealed liquid propellant supply system is being developed. Conclusions of an analysis of general relationships among the thermodynamic and spatial variables of a closed liquid propellant-propellant tank system are given. Tests show that hydrazine can be subjected to sterilization temperature cycling in a closed system. Progress was made in determining the ability of current solid propellants to withstand sterilization temperature cycling and in the design of a motor using qualified propellants with associated rocket hardware. Possible methods of decontamination prior to terminal heat sterilization are described. Design considerations for minimum stress propellant grain configurations are discussed and test results shown. Dry heat sterilization imposes no obstacles for pyrotechnic, liquid propellant, or solid propellant subsystems beyond normal development and optimization problems. R.N.A.

**N67-14800*#** Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
**RL10A-3-3 ROCKET ENGINE Design Report**
28 Feb. 1966 95 p
(Contract NAS8-15494)
(NASA-CR-80920; PWA-FR-1789) CFSTI: HC $3.00/MF $0.75 CSCL 21H

The design features of the RL10A-3-3 rocket engine are described. A design analysis is made of the propellant control system, turbopump assembly, accessory drive pad, gearbox vent orifice, thrust chamber, propellant injector, propellant piping, engine plumbing, engine mount system, electrical requirements, and ignition system. Also included are engine installation and assembly drawings, a weight breakdown, an analysis of steady state and transient performance, a propellant flow schematic drawing, a materials glossary, an engine parts list, propellants and ancillary fluids pressure and temperature requirements, and a malfunction analysis. R.N.A.

**N67-14907*#** Aerojet-General Corp., Sacramento, Calif.
**260-IN.-DIA MOTOR FEASIBILITY DEMONSTRATION PROGRAM Final Program Summary Report, Jun. 1963–Apr. 1966**
8 Apr. 1966 55 p refs
(Contract NAS3-6284)
(NASA-CR-72127) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The design of 260 inch diameter solid rocket motors, and the performance of motors 260-SL-1 and 260-SL-2 during static firing tests, are described. Problems occurring in the program with regard to fabrication of the chamber; nozzle materials; the insulation system; the liner; propellants, grain, and casting; core design and fabrication; and aft-end ignition, are discussed; and solutions to the problems are given. Test firing results with subscale motors are also presented, and information is given concerning facilities used, and schedules. A bibliography of all reports prepared on the program during the period March 1, 1965 through April 8, 1966 is listed. L.S.

**N67-14950#** AiResearch Mfg. Co., Phoenix, Ariz.
**SUMMARIZING COMBUSTION SYSTEM DEVELOPMENT, CONTAMINATED FUEL PROGRAM**
22 Jun. 1966 324 p refs
(Contract NOw-63-0790-c)
(GT-7756-R; AD-642363) CFSTI: HC $3.00/MF $0.65

The contract provides for the development of a fuel and control system that will enable a turboprop engine to operate on a wide variety of contaminated fuels. Completion of the section of the contract which concerns an analytical and experimental program to provide and substantiate the combustion chamber, fuel insertion and ignition system design concepts for the fuel system is reported. Several methods of fuel insertion were investigated to assess their suitability for use with the specified fuels and contaminants. The evaluation considered such factors as flow calibrations, spray pattern studies and the ability to pass the specified contaminants. Two means of fuel insertion were selected for development with the combustion chamber-an air-assist fuel atomizer and a sonic-type fuel nozzle. Component rig tests were conducted on two basic combustor configurations-an annular combustor that requires ten fuel nozzles and a can-type combustor that utilizes a single fuel nozzle. The annular combustor was selected as the preferred arrangement for use with the aviresearch YT76 turboprop engine, and in conjunction with ten sonic-type fuel nozzles and a standard spark ignition system, was developed to satisfy the objectives of this program phase. Author (TAB)

**N67-14968#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**VAPORIZING COMBUSTION CHAMBER OF GAS-TURBINE ENGINE AND FEATURES OF ITS OPERATION**
Ye. P. Fedorov and Yu. I. Shal'man 13 Apr. 1966 18 p refs
Transl. into ENGLISH from Avtomob. Prom. (Moscow), no. 5, 1964 p 42–45
(FTD-TT-65-1855; TT-66-62430; AD-640288) CFSTI: HC $1.00/MF $0.50

Properties and performances of ring-shaped vaporizing combustion chambers for gas turbine engines are discussed. In these chambers, the fuel air mixture passes through L-shaped vaporizing elements before ignition. Combustion basically occurs in the boundary layers of the air streams that enter the chamber through slits and the blowing vapor–air fuel. The blending of the vapor–air mixture with the air streams is the essential process which determines the dimensions of the primary zone of the fire tube in the vaporizing combustion chamber. G.G.

**N67-15157*#** Aerotherm Corp., Palo Alto, Calif.
**STUDIES OF NOZZLE ABLATIVE MATERIAL PERFORMANCE FOR LARGE SOLID BOOSTERS Final Report**
John W. Schaefer and Thomas J. Dahm 15 Dec. 1966 128 p refs
(Contract NAS7-405)
(NASA-CR-72080; Rept.-66-2) CFSTI: HC $3.00/MF $1.30 CSCL 21H

Analytical and experimental studies of nozzle ablative material performance for large solid boosters were performed. Carbon phenolic, graphite phenolic, and silica phenolic materials were considered. Predictions of material performance for three large booster nozzles (260-SL-1, 120-SS-1, and UA-1205-10) were made using ablation computer programs. An analysis of material performance was made through comparisons of the predicted and measured performance. Tests to study the ablative material performance were conducted using an arc-plasma generator to simulate the solid propellant environment; the ablative material test sections were in the form of supersonic nozzles. Char thermal conductivity was also determined under dynamic conditions using this test approach. Some special studies were performed and areas that require future study were identified. Author

**N67-15200#** Rolls-Royce, Ltd., Derby (England). Aero Div.
**FACTORS GOVERNING THE DESIGN OF TIP JET ENGINES**
G. L. Wilde and P. A. Taylor *In* AGARD Helicopter Develop. 1966 p 387–400 refs (See N67-15181 06-02) CFSTI: HC $8.81/MF $2.50

The special problems of designing a tip jet engine to achieve an acceptable standard of fuel consumption and certain other requirements, including noise, are discussed. The study considers it feasible to design a small tip turbojet of the bypass type giving 150 lb thrust and operating in a centrifugal field of the order of

800 g. The principle design problem is with the engine bearings. Oil fed plain bearings appear to be capable of standing the large loads, but improved high capacity roller bearings have lower friction and heat losses. Fatigue stresses, particularly in the compressor blading, are also a major problem, and care is needed in designing the blade root attachments to avoid stress concentrations. The engine considered is relatively complex because of the operating conditions it was designed to meet, however, a simpler engine not designed to cancel gyroscopic couples could be designed having the same nacelle diameter but with a thrust of 500 lb. R.N.A.

N67-15246# Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.
**ELECTRON CYCLOTRON PLASMA THRUSTOR FOR ORBIT CORRECTIVE MISSIONS**
H. W. Handel and T. J. Faith, Jr. *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. II 1965 p 659–677 refs (See N67-15234 05-25) CFSTI: HC $7.00/MF $1.75
(Contract AF 49(638)-1342)

An electron cyclotron resonance plasma thrustor at a microwave frequency of 2.45 Gc is described and discussed in relation to an orbit corrective mission for a 1500 lb synchronous satellite. A laboratory model thrustor operating at a microwave input power level of 50 watts has achieved an electrical efficiency of 30% and a fuel utilization efficiency of 50%. The thrustor system weight for the mission considered is less than one tenth the weight of the total satellite system. This type of device appears to be highly reliable, having been run for over 1500 hours at 50 watts microwave power level with no noticeable deterioration. Author

# 29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N67-14461*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**A PRELIMINARY REPORT ON ENERGETIC SPACE RADIATION AND DOSE RATE ANALYSIS**
M. O. Burrell, J. J. Wright, and J. W. Watts 31 Oct. 1966 43 p refs
(NASA-TM-X-53531) CFSTI: HC $2.00/MF $0.50 CSCL 20H

The purpose of this study is to present a compendium of the environmental data on trapped and untrapped radiation and the calculated tissue dose rates received from these radiations and their secondaries behind various shield thicknesses. Energetic radiation, as used here, refers to particles with energies greater than about 500 kilo-electron volts. The results given in this report should be of practical value for preliminary analysis of the radiation hazard to man during space flight. Author

N67-14712# Avco-Everett Research Lab., Everett, Mass.
**LABORATORY MODELING OF THE SOLAR WIND**
R. M. Patrick and E. R. Pugh Aug. 1966 17 p refs
(Contract AF 49(638)-1483; AF 19(628)-6066)
(AMP-204; AFOSR-66-2055; AD-640407) CFSTI: HC $1.00/MF $0.50

The IMP satellite measurement and a theoretical study indicate that the solar wind interaction with the earth's B field has properties similar to a continuum flow. This has motivated us to build a laboratory facility which simulates this flow, and produces a steady flow of collisionless plasma with a large diameter compared to the ion gyro radii. A description of this facility, the design criteria and some results of flow studies will be given. Author (TAB)

N67-14865# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**STUDY OF THE MOTION OF CHARGED PARTICLES IN THE FIELD OF A MAGNETIC DIPOLE IN AN EXTERNAL MAGNETIC FIELD BY THE STOERMER METHOD, I**
V. P. Shalimov and I. N. Shvachunov *In its* Cosmic Res. 4 Aug. 1966 p 49–68 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

The Strömer method is used to solve the problem of charged-particle motion in the field of a magnetic dipole situated in an external homogeneous magnetic field $\vec{H}_0$ that is antiparallel to the vector $\vec{M}$ of the dipole magnetic moment. It is shown that the shape and dimensions of the permitted and forbidden regions depend on particle energy even if the Störmer unit of length is used as the scale. There is a threshold value of particle energy, which depends on the relation between $H_0$ and M such that if the particle energy is below the threshold, there exist only interior permitted regions for all values of the Störmer constant $\gamma$. If the particle energy is above the threshold, then, depending on the values of $\gamma$, there exist both interior and exterior permitted regions, which are connected at $\gamma=\gamma^-$, with the magnitude of $\gamma^*$ also dependent on particle energy. Author

N67-14870# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
***INVESTIGATION OF EMISSION INTENSITY IN THE RADIATION BELTS OF THE EARTH WITH THE "KOSMOS-17" ARTIFICIAL EARTH SATELLITE***
G. A. Kirdina, Yu. M. Kulagin, A. B. Malyshev, M. N. Nazarova, P. M. Svidskiy et al *In its* Cosmic Res. 4 Aug. 1966 p 128–143 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

Data are presented on the registration of charged-particle flows in the radiation belts of the earth by means of Geiger and scintillation counters in an altitude range from 260 to 780 km during the period from 22 through 30 May 1963. It has been established that according to the composition of the particles penetrating a screen $\approx 1$ g/cm$^2$, the inner radiation bdlt may be divided into two regions: with L from 1.15 to 1.6 the main portion of the flow is produced by electrons of nuclear explosion, while for L from 1.6 through 2.5 the flow is produced by protons. The flow of protons with energies of $E_p > 30$ MeV increased in comparison with 1958. In the space between the inner and outer radiation belts a narrow region has been detected in which have been recorded electrons exhibiting energies of $0.1 \leq E_e \leq 1.5$ MeV. Beneath the lower boundary of the inside belt stable flows of soft corpuscles have been detected and these, apparently, involve electrons with energies of 50–100 keV. Author

N67-14871# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**REGISTRATION OF COSMIC RAYS ABOARD THE "KOSMOS-17" ARTIFICIAL EARTH SATELLITE**
S. I. Avdyushin, R. M. Kogan, M. N. Nazarova, N. K. Pereyaslova, I. Ye. Petrenko et al *In its* Cosmic Res. 4 Aug. p 144–165 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

We present the results obtained in the measurement of cosmic radiation intensity outside the radiation belts of the earth as a function of the L coordinate. The mean value of the radiation intensity varies from 0.5 to 3.0 cm$^{-2}$·sec$^{-1}$ for charged particles and from 9 to 22 cm$^{-2}$sec$^{-1}$ for gamma-quants. The high-latitude cutoff for the spectrum of cosmic rays is bound to occur at a hardness R = 1.6 BeV. An "equator" of cosmic rays has been

constructed for altitudes of 400–600 km. Data are also presented on the recording of showers with spread angles in excess of 60° occurring on the interaction of cosmic particles with the material of the satellite. The mean characteristics of these showers are the following: particle density in the shower $n_w = 0.038$ cm$^{-2}$; total number of particles in the shower $\approx 10^2$; the ratio of the number of protons to the number of corpuscles in the shower, $\alpha = 11.3$. Author

N67-14884*# TRW Systems, Redondo Beach, Calif. Space Sciences Lab.

**CHARACTERISTICS OF THE SOLAR WIND-MAGNETOSPHERE TRANSITION REGION, APPENDIX A**

Frederick L. Scarf 15 Sep. 1966 12 p refs

(Contract NASw-1366)

(NASA-CR-80950; TRW-06500-6002-RO-000) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The concept of a collisionless shock transition between the magnetosphere and the free streaming solar wind was originally introduced on the grounds that the interplanetary magnetic field would, somehow, bind the collisionless plasma into a conventional fluid. Details of the dissipation mechanisms were avoided, and aerodynamic analogies were used to compute the location of the shock boundary, assuming that the relevant Mach number is $(u/V_A)$, where u is the wind speed and $V_A$ is the Alfvén wave speed. To an amazing extent, these rough kinematical techniques do provide an accurate statistical prediction for the location of the mean proton boundary, or magnetopause, and the mean shock boundary, or position where the solar wind is first disturbed. However, to a large degree these predictions of the fluid or mhd model are the only ones which appear to have any detailed validity. Author

N67-14886*# TRW Systems, Redondo Beach, Calif. Space Sciences Lab.

**A PLASMA INSTABILITY IN THE SOLAR WIND, APPENDIX B**

F. L. Scarf, J. H. Wolfe, and R. W. Silva (NASA. Ames Res. Center) 3 Aug. 1966 39 p refs Presented at the Inter-Union Symp. on Solar Terrest. Phys., Belgrade

(Contract NASw-1366)

(NASA-CR-80951; TRW-06500-6001-RO-000) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Recent solar wind measurements on the Pioneer 6 spacecraft reveal that, in general, the proton velocity distribution is highly anisotropic with $T_{\parallel} > T_{\perp}$, where the subscripts refer to direction with respect to the interplanetary magnetic field. A mechanism which can produce such an anisotropy is considered, and the consequences of the particle distribution with respect to stability of the plasma are analyzed. It is shown that a generalized form of the firehose instability must occur, with growth of magnetosonic (whistler mode) waves near the ion cyclotron frequency. Growth rates are computed for a range of wave frequencies and distances from the sun, and these predictions are compared with available interplanetary power spectra. Author

N67-14933*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**ELECTRON DENSITIES AND SCALE HEIGHTS IN THE TOPSIDE IONOSPHERE: ALOUETTE I OBSERVATIONS OVER THE AMERICAN CONTINENTS VOLUME III: JUNE, JULY, AND SEPTEMBER 1963**

Kwok-Long Chan, Lawrence Colin, and John O. Thomas Washington, NASA, 1966 584 p refs

(NASA-SP-3033, Vol. III) CFSTI: HC $6.25/MF $5.85 CSCL 20H

Data on electron density and plasma scale height at various heights and times in the topside ionosphere are presented in tabular form. The data were computed from Alouette I topside sounder ionograms. Information is given on the Alouette satellite, selection of ionograms, and use of the tabulations. L.E.W.

N67-14988# Air Force Cambridge Research Labs., Bedford, Mass. Space Physics Lab.

**CORPUSCULAR RADIATION ENVIRONMENT OF A LOW-ALTITUDE, POLAR-ORBITING EARTH SATELLITE—A BRIEF SUMMARY**

Vern G. Smalley, Don F. Smart, and Robert C. Fitz Aug. 1966 40 p refs *Its* AF Survey in Geophys. No. 185

(AFCRL-66-540; AD-640323) CFSTI: HC $2.00/MF $0.50

The report summarizes the most recent determinations of particulate fluxes, flux rates, and energies for geomagnetically trapped radiation, galactic cosmic rays, and solar cosmic rays encountered by low-altitude, polar orbiting satellites. Author (TAB)

N67-15105# Oslo Univ., Blindern (Norway). Inst. of Theoretical Astrophysics.

**ON SOME PROPERTIES OF SOLAR STORM BURSTS IN THE 200 MC/S REGION**

Hans Kr. Eckhoff 1966 34 p refs

(Contract AF 61(052)-743)

(AFCRL-66-713; SR-13; AD-642577) CFSTI: HC $3.00/MF $0.65

More than 4000 storm bursts recorded with the swept frequency receiver at Harestua during an intense noise storm occurring in August, 1961, were analyzed. From the recordings three periods were selected for a close examination. During one of these a very remarkable change in burst duration took place. The abnormal conditions lasted for some minutes and the period is henceforth referred to as the 'flash-period'. The mean 'total duration' of the storm bursts occurring outside the flash period was found to be 0.43 seconds and the mean 'total bandwidth' amounted to 5.6 mc/s. During the flash period the mean total duration of the bursts decreased to 0.22 seconds and also the spread in burst durations diminished. No change in the distribution of burst bandwidths was found during the flash-period. Frequency drift is discussed in connection with 'flash-bursts' and ordinary Type I bursts. Many complex bursts were studied by means of an isodensitometer. As a result of this a maximum duration of 0.8 seconds was established for the bursts in the material. Author (TAB)

N67-15155# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**ENTRY OF SOLAR COSMIC RAYS INTO THE POLAR CAP ATMOSPHERE**

Yukio Hakura (Radio Res. Labs.) Nov. 1966 40 p refs

(NASA-TM-X-55637; X-641-66-521) CFSTI: HC $3.00/MF $0.65 CSCL 20H

World-wide fmin records are used to analyze onset patterns of polar cap atmosphere, PCA, due to enhanced ionization caused by penetrating solar particles. The initial phase of PCA consists of at least three characteristic stages that occur successively in different zones of the polar region: the first stage is observed as a slightly enhanced ionization near the geomagnetic pole; the second stage as a remarkable development of PCA in the polar cap above 65° and the third stage as an extension of the enhanced ionization down to latitudes of 60° or lower. A diffusion model of interplanetary space suggests that the three stages are due to differential arrival of solar electrons, protons, and α-particles at the polar atmosphere. The importance of α-particles to the third stage is established by using known incident spectra of both solar protons and α-particles. An empirical relation between particle rigidity and geomagnetic latitude shows a uniform reduction

of the Störmer rigidity cutoff by some 70% in the interval 55°–65° in corrected geomagnetic latitude, and a disappearance of cutoff in the polar cap above 65°. Author

**N67-15320*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**ROCKET OBSERVATIONS OF LOW ENERGY AURORAL ELECTRONS**
David S. Evans Aug. 1966 42 p refs
(NASA-TM-X-55617; X-611-66-376) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Solar activity and subsequent auroral display, solar wind to provide energy, and the energization of auroral particles are some topics briefly reviewed in this literature survey. Details are given on instrumentation for rocket payload soundings to detect primary auroral electrons, and results of measurements of the primary electron influx associated with the aurora. The most significant result of the auroral electron measurements performed on two flights described is the observation on two separate occasions of differential energy spectrums which are suggestive of electrostatic acceleration mechanisms having been responsible for the energization of auroral electrons. It is further seen that the process responsible for the electron flux exhibited great stability in time, and the homogeneous nature of the influx over 50 km distance. These points serve to eliminate more dynamic mechanisms as the source of electron energization and precipitation. R.Li.

# 30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

**N67-14374#** Smithsonian Astrophysical Observatory, Cambridge, Mass.
**INDEX TO SAO SPECIAL REPORTS NUMBERS 1 THROUGH 199, OCTOBER 14, 1957–FEBRUARY 3, 1966**
7 Nov. 1966 120 p refs

This index covers the materials published in the SAP Special Reports Numbers 1 through 199, issued between October 14, 1957, and February 3, 1966. It supersedes the Index of Special Reports 1 through 150, published June 30, 1965. Included are an abstract index, author index, title index, and significant references to individual satellites. Author

**N67-14405*#** Liverpool Univ. (England).
**DECAY OF ORBITS**
P. J. Message *In* Wis. Univ. Lectures in Appl. Math. Vol. 7: Space Math., Pt. 3 1966 p 153–166 refs (See N67-14401 05-12) CFSTI: HC $7.00/MF $1.50

Drag force expressions are derived for the idealized and practical cases, and an approximation is presented for the effect of atmospheric rotation. Equations are also derived for the effect of the tangential component. In considering the form of the atmosphere, the surfaces of constant density are assumed to be ellipsoids of revolution, with the earth's rotational axis as the axis of symmetry and the ellipticity of each ellipsoid the same as that of the geoid. Approximate equations of motion are formulated for orbital eccentricities. The effect of the drag force on the apse, the node, and the inclination, including the nontangential components, is taken into account. N.A.S.

**N67-14406*#** Tokyo Univ. (Japan).
**THE EFFECT OF RADIATION PRESSURE ON THE MOTION OF AN ARTIFICIAL SATELLITE**
Gen-Ichiro Hori *In* Wis. Univ. Lectures in Appl. Math. Vol. 7: Space Math., Pt. 3 1966 p 167–178 refs (See N67-14401 05-12) CFSTI: HC $7.00/MF $1.50

Based on a successive approximation method, equations of motion are derived for an artificial satellite orbiting around the oblate earth and disturbed by solar radiation pressure. Consideration is given to the elimination of short and long period terms, as well as to resonance, double resonance, and nonresonance cases. N.A.S.

**N67-14409*#** Aeronautical Research Associates of Princeton, Inc., N. J.
**RENDEZVOUS PROBLEM**
J. C. Houbolt *In* Wis. Univ. Lectures in Appl. Math. Vol. 7: Space Math., Pt. 3 1966 p 276–301 (See N67-14401 05-12) CFSTI: HC $7.00/MF $1.50

The ascent and injection into transfer orbit, and the terminal phase of the rendezvous problem are discussed. The velocity penalty for equal velocities in-plane, two-impulse, and dog-leg maneuvers are described. The Hohmann-type transfer is illustrated for the general ascent and for the case when parking orbits are used to extend the launch window. The terminal maneuvers of proportional navigation and orbital mechanics are considered. Mission analysis is presented for two lunar mission profiles: direct ascent, and direct ascent with rendezvous in parking orbit about the moon. Rendezvous concepts and paths for interplanetary flights are also described. N.E.N.

**N67-14410*#** Wisconsin Univ., Madison. Mathematics Research Center.
**LECTURES IN APPLIED MATHEMATICS. VOLUME 5: SPACE MATHEMATICS, PART 1**
J. Barkley Rosser, ed. Providence, R. I., Am. Mathematical Soc., 1966 300 p refs Proc. of the 3d Summer Seminar in Appl. Math., Ithaca, N. Y., 1963
(Grant NsG-358; Contracts DA-31-124-ARO(D)-82; AT(30-1)-3164; Nonr(G)-00025-63; Grant NSF GE-2234 et al)
(NASA-CR-80874) CFSTI: HC $6.00/MF $1.50 CSCL 22C

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2. MATRIX METHODS J. M. A. Danby (Yale Univ.) p 32–39 refs (See N67-14412 05-19)

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10. QUALITATIVE METHODS IN THE n-BODY PROBLEM H. Pollard p 259–291 refs (See N67-14420 05-23)

N67-14411*# Yale Univ. Observatory, New Haven, Conn.
**ELLIPTIC MOTION**
J. M. A. Danby *In* Wis. Univ. Lectures in Appl. Math. Vol. 5: Space Math., Pt. 1 1966 p 1–31 refs (See N67-14410 05-30) CFSTI: HC $6.00/MF $1.50

Newtonian mechanics and the two-body problem are reviewed with respect to conic motion. Keplerian orbits are described, and the use of series to express the eccentric anomaly is discussed, with emphasis on the application of Fourier series. N.E.N.

N67-14414*# Liverpool Univ. (England).
**STABILITY AND SMALL OSCILLATIONS ABOUT EQUILIBRIUM AND PERIODIC MOTIONS**
P. J. Message *In* Wis. Univ. Lectures in Appl. Math. Vol. 5: Space Math., Pt. 1 1966 p 77–89 refs (See N67-14410 05-30) CFSTI: HC $6.00/MF $1.50

Poincare's method of treating periodic motions in general and his application to the general motion problem of three bodies is extended to the main problem of the lunar motion reflecting both the sun's and the earth's effects. Employing the equations of linear variation, the motion in the vicinity of a periodic solution or equilibrium configuration is investigated. N.E.N.

N67-14416*# National Bureau of Standards, Washington, D. C.
**THE SPHEROIDAL METHOD IN SATELLITE ASTRONOMY**
John P. Vinti *In* Wis. Univ. Lectures in Appl. Math. Vol. 5: Space Math., Pt. 1 1966 p 119–129 refs (See N67-14410 05-30) CFSTI: HC $6.00/MF $1.50

The Hamilton–Jacobi equation written in oblate spheroidal coordinates is used to obtain a reference orbit as a starting point for the calculation of satellite orbits. The resulting expressions for the gravitational potential and the Keplerian elements are discussed, and the kinetic equations are solved. The necessary perturbation theory is described. N.E.N.

N67-14417*# Liverpool Univ. (England).
**PRECESSION AND NUTATION**
Alan Fletcher *In* Wis. Univ. Lectures in Appl Math. Vol. 5: Space Math., Pt. 1 1966 p 130–149 refs (See N67-14410 05-30) CFSTI: HC $6.00/MF $1.50

Mathematical expressions are developed for the lunar and earth orbital motion. The derivation of couples, the effect of solar and lunar couples on rotation and nutation, the gravitational potential, orbital inclination and retrogression, and polar motion are considered. N.E.N.

N67-14418*# Yale Univ. Observatory, New Haven, Conn.
**ON AN IRREVERSIBLE DYNAMICAL SYSTEM WITH TWO DEGREES OF FREEDOM: THE RESTRICTED PROBLEM OF THREE BODIES**
Victor Szebehely *In* Wis. Univ. Lectures in Appl. Math. Vol. 5: Space Math., Pt. 1 1966 p 150–168 refs (See N67-14410 05-30) CFSTI: HC $6.00/MF $1.50

Typical results are sketched of the formalistic and qualitative approaches to the problem of the motion of one body moving in the plane defined by two bodies, revolving under the influence of their mutual gravitational attraction, and which attract the first body but are not influenced by it. The relationship to the general three-body problem is described. The reductions of the equations of motion and the regularization of the restricted problem are discussed. N.E.N.

N67-14419*# Thessaloniki Univ. (Greece).
**PROBLEMS OF STELLAR DYNAMICS**
George Contopoulos *In* Wis. Univ. Lectures in Appl. Math. Vol. 5: Space Math., Pt. 1 1966 p 169–258 refs (See N67-14410 05-30) CFSTI: HC $6.00/MF $1.50

The techniques used in stellar dynamics research are reviewed. The virial theorem, Poincaré's recurrence theorem, and Hopf's theorems with respect to the n-body system are discussed. The gravitating continuum approach for a large number of stars in a stellar system is described with respect to the distribution function, integrals of motion, and galactic orbits. The statistical method is used for calculating the time of relaxation or mean free path of a stellar system, and the study of the velocity and density distribution of a cluster. N.E.N.

N67-14623*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**RADIO ASTRONOMY**
D. H. Staelin, R. W. Neal, S. E. Law, E. C. Reifenstein, B. F. Burke et al *In its* Res. Lab. of Electron. 15 Oct. 1966 p 7–14 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25

Three studies are presented: (1) The physical conditions responsible for the anomalously intense sources of 18-cm line emission at radio frequencies were investigated by interferometry to determine the angular dimensions of the emitting regions. The interferometer was composed of the Millstone (84-ft) and Haystack (120-ft) antennas, with a baseline of approximately 3800λ at 18 cm, along a line nearly 20° east of north. The observed OH emission sources were of small angular size. (2) In a low-frequency aperture synthesis of discrete radio sources, the fringe visibilities of approximately 24 of the brightest radio sources were measured at a frequency of 234 MHz using a long-baseline interferometer with additional equipment. The structures of many of these sources were obtained by a variety of digital computer processings. (3) As part of a search for atmospheric spectral features, the planets Venus and Jupiter were observed from January to March, 1966, at wavelengths near 1 cm. A 28-ft antenna and a five-channel microwave radiometer were used; they were operated simultaneously. K.W.

N67-14746# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
**THE DENSITY OF INTERSTELLAR MATTER NEAR A STAR**
T. A. Brey and J. M. A. Danby (Yale Univ.) Sep. 1966 17 p refs *Its* Math. Note No. 480
(D1-82-0563; AD-640017) CFSTI: HC $1.00/MF $0.50

The problem of the gravitational enhancement of the density of interstellar matter near a star is considered, where the temperature of this matter is not zero at great distances from the star. In general this enhanced density will still be less than that of the surrounding particles that are intrinsic to the star itself, and the enhancement of density will not in itself be of prime importance in the discussion of collisions. Author (TAB)

N67-14752# RAND Corp., Santa Monica, Calif.
**ON THE CHARACTERISTICS OF FAMILIES OF SATELLITES IN COPLANAR, CIRCULAR ORBIT**
G. M. Northrop Sep. 1966 47 p refs
(Contract AF 49(638)-1700; Proj. RAND)
(RM-5155-PR; AD-640466) CFSTI: HC $2.00/MF $0.50

An analysis of the orbital characteristics of families of satellites in coplanar, circular orbit is made from a deterministic, rather than a random, point of view. The analytic results provide a basic structure that can be used in the design and planning of satellite

systems for communications, weather, navigation, and warning. The basic equations describing satellite orbits are used to predict initial spreading characteristics, drift rate, potential bunching configurations, and bunching durations. Because of the complexity introduced by multiple-member families of satellites, a computer technique is used in these cases. Two spacing schemes for satellites in unperturbed, circular, coplanar orbit illustrate the analysis. Author (TAB)

**N67-14791*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**EFFECTS OF STERILIZATION ON SEPARATION, ENTRY, DESCENT, AND LANDING PHASES OF A CAPSULE MISSION FROM AN ENGINEERING MECHANICS PERSPECTIVE**
Dwain F. Spencer *In* NASA, Washington Spacecraft Sterilization p 461–471 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

A discussion is presented of certain problems, and of the status of the approaches to the solution of these problems, associated with the capsule separation, descent, and landing phases of a Mars mission. A distinction is made between problems associated with the ability of a particular subsystem to withstand the sterilization environment and operate properly and those problems associated with possible recontamination of the capsule at some time after the capsule has undergone terminal heat sterilization. The recontamination problems arising during the capsule-spacecraft separation phase in the vicinity of Mars is stressed. The discussion of recontamination of the capsule by the spacecraft assumes a nonsterile spacecraft. Author

**N67-14848#** Comitato Nazionale per le Manifestazioni Celebrative, Florence (Italy).
**PROCEEDINGS OF THE MEETING ON COSMOLOGY**
G. Barbera, ed. 1966 205 p refs Meeting held in Padua and Venice, 14–16 Sep. 1964 *Its* Vol. II, No. 3
CFSTI: HC $8.00/MF $1.25

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6. OPTICAL OBSERVATIONS RELATING TO COSMOLOGY WITH SPECIAL REFERENCE TO THE PROBLEM OF THE FORMATION AND EVOLUTION OF GALAXIES E. M. Burbridge (Calif. Univ.) p 64–81 refs (See N67-14854 05-30)

7. RADIO OBSERVATIONS AND COSMOLOGY R. Minkowski (Calif. Univ.) p 82–95 refs (See N67-14855 05-30)

8. VIOLENT RELEASES OF ENERGY IN GALAXIES AND THEIR BEARING ON GALACTIC EVOLUTION AND COSMOLOGY G. Burbidge (Calif. Univ.) p 96–103 (See N67-14856 05-30)

9. RADIO SOURCES AND THE EXPANSION OF THE UNIVERSE A. Sandage (Mount Wilson Obs.) p 104–121 refs (See N67-14857 05-30)

10. SUPERNOVAE AND ERUPTIVE GALAXIES R. Zwicky (Calif. Inst. of Tech.) p 122–152 refs (See N67-14858 05-30)

11. HIGHLY COLLAPSED STARS L. Gratton (Rome Univ.) p 153–184 refs (See N67-14859 05-30)

12. COSMOLOGICAL IMPLICATIONS OF NEUTRINO EMISSION BY PAIR ANNIHILATION IN MASSIVE STARS W. A. Fowler (Calif. Inst. of Tech.) p 185–203 refs (See N67-14860 05-30)

**N67-14849#** Illinois Univ., Urbana.
**THE ANALYSIS OF OBSERVATIONS IN COSMOLOGY**
G. C. McVittie In Comitato Nazl. per le Manifestazioni Celebrative Proc. of the Meeting on Cosmology 1966 p 13–21 refs (See N67-14848 05-30) CFSTI: HC $8.00/MF $1.25

The rationalist and empirical approaches to cosmology are reviewed and contrasted. The difference in methods is illustrated with the treatment of the red-shift data and with the average density of matter in space. Emphasis is placed on the empirical approach, and on the results from combining the negative acceleration factor and a density of $10^{-30}$–$10^{-31}$ gm/cm$^3$ with the Einstein relativity equations. N.E.N.

**N67-14850#** Texas Univ., Austin.
**RELATIVISTIC COSMOLOGY**
E. L. Schuecking *In* Comitato Nazl. per le Manifestazioni Celebrative Proc. of the Meeting on Cosmology 1966 p 22–30 (See N67-14848 05-30) CFSTI: $8.00/MF $1.25
(Grants AF-AFOSR-453-63; AF-AFOSR-454-64)

The possibility of gravitational fields not yet observed, and the absence of boundary conditions for the fields in Einstein's theory are discussed. The electrostatic potential and Newton's theory without boundary conditions are combined, and centrifugal and gravitational forces are considered for a rigidly rotating dust sphere in an empty world. The Weyl and Ricci tensors, and the Friedmann model are also discussed. N.E.N.

**N67-14851#** London Univ. (England). King's Coll.
**STEADY-STATE COSMOLOGY**
H. Bondi *In* Comitato Nazl. per le Manifestazioni Celebrative Proc. of the Meeting on Cosmology 1966 p 31–36 (See N67-14848 05-30) CFSTI: HC $8.00/MF $1.25

The testability of the steady state theory, due to the minimum number of assumptions, is discussed. The achievements of the theory are outlined, and the influence on the modern theory of the origin of the elements is mentioned. The problems in formulation of the theory, with respect to uniform and unchanging characteristics, are indicated. N.E.N.

**N67-14852#** Texas Univ., Austin.
**THE VELOCITY-DISTANCE RELATION FOR BRIGHT GALAXIES**
G. de Vaucouleurs *In* Comitato Nazl. per le Manifestazioni Celebrative Proc. of the Meeting on Cosmology 1966 p 37–46 refs Sponsored by ONR (See N67-14848 05-30) CFSTI: HC $8.00/MF $1.25

The problems connected with galactic luminosity function, nonlinearity and anisotropy, and magnitude and velocity are examined. Spirals with a DDO luminosity classification and mean velocities of galaxies of all types are discussed. Among the conclusions are: (1) The large anisotropy in the surface density distribution of the brighter galaxies is reflected in the velocity distribution. (2) The velocity–magnitude relation differs significantly in different directions of the supergalactic equatorial belt. (3) The ratio of the mean velocity of the Virgo cluster to some estimated distance is not a reliable estimate of the coefficient of the universal red shift. (4) The supergalactic polar caps are the best suited regions to establish the general law of red shifts. N.E.N.

N67-14853# Moscow State Univ. (USSR).
**EVIDENCE OF MAGNETIC-LIKE PHENOMENA IN THE STRUCTURE OF GALAXIES AND THEIR COSMOLOGICAL MEANING**
B. Vorontsov-Velyaminov *In* Comitato Nazl. per le Manifestazioni Celebrative Proc. of the Meeting on Cosmology 1966 p 47–63 refs (See N67-14848 05-30) CFSTI: HC$6.00/MF$1.25

The evidences of magnetic-like phenomena are discussed, and the radial formations and elements in the galactic structure are described. Phenomena in favor of magnetic origin of galaxies, and in favor of magnetic-like origin are considered, and it is suggested that magnetic-like phenomena are present. N.E.N.

N67-14854# California Univ., La Jolla.
**OPTICAL OBSERVATIONS RELATING TO COSMOLOGY WITH SPECIAL REFERENCE TO THE PROBLEM OF THE FORMATION AND EVOLUTION OF GALAXIES**
E. M. Burbidge *In* Comitato Nazl. per le Manifestazioni Celebrative Proc. of the Meeting on Cosmology 1966 p 64–81 refs (See N67-14848 05-30) CFSTI: HC$6.00/MF$1.25

The observations which may pertain to the problem of the formation and early history of galaxies, and how the observable quantities will be expected to be different at an early stage than they are at present are discussed. Thermal instability as an efficient mechanism of condensation is considered, and irregular galaxies are described whose spectra, large dimensions, and cylindrical form may indicate their youth. It is suggested that the cylindrical structures may also indicate a magnetic field and an external pressure. The possibility of stellar dust and gaseous matter being captured by a galaxy is mentioned. N.E.N.

N67-14855# California Univ., Berkeley. Radio Astronomy Lab.
**RADIO OBSERVATIONS AND COSMOLOGY**
R. Minkowski *In* Comitato Nazl. per le Manifestazioni Celebrative Proc. of the Meeting on Cosmology 1966 p 82–95 refs (See N67-14848 05-30) CFSTI: HC$6.00/MF$1.25

Observations of nonthermal radio sources of interest in cosmological research are summarized. The associations of non-quasi-stellar sources and of quasi-stellar sources with galaxies and clusters of galaxies are discussed. The characteristics of the spectra of radio sources, and the difficulties in trying to determine the red shifts, flux densities, and size of source are described. The actual source counts, the theoretically computed counts, and the discrepancies between them are considered. It is suggested that it is not now possible to decide whether or not the source counts are consistent with an evolutionary cosmological model. On the other hand, it may also be that the source counts may contain unique information on evolutionary problems from the largest distances accessible to observation. N.E.N.

N67-14856# California Univ., La Jolla.
**VIOLENT RELEASES OF ENERGY IN GALAXIES AND THEIR BEARING ON GALACTIC EVOLUTION AND COSMOLOGY**
G. Burbidge *In* Comitato Nazl. per le Manifestazioni Celebrative Proc. of the Meeting on Cosmology 1966 p 96–103 (See N67-14848 05-30) CFSTI: HC$6.00/MF$1.25

The evidence of violent activity originating in the nuclei of galaxies, the energy involved, and the energy sources are described. The known data about the Seyfert spiral galaxies are reviewed. The characteristics of radio galaxies are outlined, and it is concluded on the basis of equipartition that the energies involved are in excess of $10^{60}$ erg. The relativistic particle component of the released energy is emphasized, and the nuclear and gravitational energies are discussed as energy sources. N.E.N.

N67-14857# Mount Wilson Observatory, Pasadena, Calif.
**RADIO SOURCES AND THE EXPANSION OF THE UNIVERSE**
A. Sandage (Palomar Observatory) *In* Comitato Nazl. per le Manifestazioni Celebrative Proc. of the Meeting on Cosmology 1966 p 104–121 refs (See N67-14848 05-30) CFSTI: HC $6.00/MF$1.25

Red shift corrections, red shift–apparent magnitude relations, and recent data on quasi-stellar radio sources are reviewed. The K term for correcting the photometric data on red shifts is described, and energy distribution curves are compared. The red shift–apparent magnitude relations for the first ranked member of clusters and for identified radio sources are discussed. The aperture correction is considered crucial because systematic errors can be introduced between nearby and distant galaxies. It is concluded that radio galaxies are as bright as the brightest member of clusters, that it is expected to find radio sources in clusters, and that clusters have no particular significance for the generation of radio energy, but are only incidental to the problem. The possibility of Lyman alpha detection is mentioned. N.E.N.

N67-14858# California Inst. of Tech., Pasadena.
**SUPERNOVAE AND ERUPTIVE GALAXIES**
F. Zwicky *In* Comitato Nazl. per le Manifestazioni Celebrative Proc. of the Meeting on Cosmology 1966 p 122–152 refs (See N67-14848 05-30) CFSTI: HC$6.00/MF$1.25

Characteristics of families of compact galaxies, and circumstances which cause a compact galaxy to implode are discussed. The slow formation of compact luminous galaxies is outlined, and it is considered that whenever an implosion or compacting process of matter takes place, an explosion follows which carries away some matter and radiation. The discovery of compact galaxies, compact pairs of galaxies, and groups of compact objects is mentioned, along with the formation of compact stars and compact galaxies. The major characteristics of supernovae and the effects of supernova explosion on other bodies are described. Causes of implosions of compact luminous galaxies or radio galaxies are discussed. N.E.N.

N67-14859# Rome Univ. (Italy). Astrophysical Lab.
**HIGHLY COLLAPSED STARS**
L. Gratton *In* Comitato Nazl. per le Manifestazioni Celebrative Proc. of the Meeting on Cosmology 1966 p 153–184 refs (See N67-14848 05-30) CFSTI: HC$6.00/MF$1.25

An astrophysical discussion is presented on highly collapsed stars, in which the general relativity effects become important. Mathematical expressions are developed for the equations of state, the gravitational equations, and equilibrium equation integrations. The extreme relativistic case and the stability against small radial oscillations are discussed. Applications are presented for the case of neutron stars at zero temperatures, and of very large masses with relatively low densities at rather high temperatures. N.E.N.

N67-14860# California Inst. of Tech., Pasadena.
**COSMOLOGICAL IMPLICATIONS OF NEUTRINO EMISSION BY PAIR ANNIHILATION IN MASSIVE STARS**
W. A. Fowler *In* Comitato Nazl. Per Le Manifestazioni Celebrative Proc. of the Meeting on Cosmology 1966 p 185–203 refs (See N67-14848 05-30) CFSTI: HC$6.00/MF$1.25
(Grant NGR-05-002-028; Contract Nonr-220(47))

The circumstantial evidence for neutrino and antineutrino emission in electron-positron pair annihilation at the rate predicted on the basis of the universality of weak interaction is reviewed. Details are presented on the emission during the equilibrium process. The implications of neutrino emission by astronomical objects is discussed. N.E.N.

**N67-14861#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**COSMIC RESEARCH**

4 Aug. 1966 280 p refs Transl. into ENGLISH of Kosmich. Issled. (Moscow), v. 4, no. 2, 1966 p179-335 (FTD-HT-66-244; TT-66-62450; AD-640326) CFSTI: HC $6.00/MF $1.50

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**N67-14862#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**DETERMINATION OF AN ARTIFICIAL EARTH SATELLITE ORBIT FROM MEASURED DATA TAKEN OVER LONG TIME INTERVALS**

V. D. Yastrebov *In its* Cosmic Res. 4 Aug. 1966 p 1-23 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

A polynomial method for determining the orbit of an artificial earth satellite from measured data taken over long time intervals is set forth. It is shown that in determining the coefficients of the approximating polynomials on the basis of trajectory-measurement reduction, it is necessary to introduce additional conditional equations to account for the kinematic relationships connecting the polynomial coefficients. An error estimate for the polynomial method as compared with conventional methods is given on the basis of analysis of results from determination of satellite orbits. Author

**N67-14863#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**FLYWHEEL STABILIZATION OF SATELLITE RELATIVE EQUILIBRIUM**

A. A. Anchev *In its* Cosmic Res. 4 Aug. 1966 p 24-39 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

The paper considers the relative equilibrium of a satellite with stabilizing flywheels built into its hull. A motion regime is indicated for the stabilizing flywheels, which hold the satellite to a given orientation as its center of mass moves along a circular orbit, and sufficient conditions are also indicated for the stability of the satellite's motion. Author

**N67-14864#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**CONTROL OF A SPACE VEHICLE WITH LOW-THRUST ENGINES ON THE ACCELERATING SEGMENT IN THE ABSENCE OF INFORMATION ON THE PRESENT VELOCITY VECTOR**

I. A. Boguslavskiy, O. I. Ivashchenko, and Yu. G. Shepelev *In its* Cosmic Res. 4 Aug. 1966 p 40-48 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

The paper examines a method of three-dimensional control of a space vehicle with low-thrust engines on an accelerating segment such that information as to the present velocity vector is not required. Author

**N67-14874#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**INTERPRETATION OF MAGNETIC MEASUREMENTS ABOARD THE "PIONEER-1" AND ITS GEOPHYSICAL CONSEQUENCES**

M. A. Gintsburg *In its* Cosmic Res. 4 Aug. 1966 p 195–207 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

A collision-free shock wave at the earth is possible because it is oblique. An oblique shock wave consists of solitary pulses. The first part of this article analyzes the properties of these pulses (amplitude, polarization) as a function of velocity and the angle $\theta$. The second portion of this article develops the hypothesis that acceleration in the vicinity of the earth of soft electrons ($E \approx 1$ keV, the third outer charged-particle belt, the electrons of the polar aurorae, the electrons ionizing the night ionosphere), as well as of electrons with energies of $E \leq 40$ keV (the outer radiation belt) proceeds precisely in such oblique pulses. Experimental verification of this hypothesis is presented in addition to various of its morphological consequences. Author

N67-14878# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**THE MOTION OF A ROCKET IN THE CENTRAL FORCE FIELD WITH A CONSTANT REACTION-ACCELERATION VECTOR**

A. L. Kunitsyn *In its* Cosmic Res. 4 Aug. 1966 p 248–254 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

Technical literature is reviewed on rocket motion in a central force field with constant reaction-acceleration vector reduced to quadratures, as well as on the same problem regarded as the limit version of the problem of two fixed centers, employed in the study of space vehicle motion in a sphere of planetary action. In amplification thereof, rocket space trajectories are classified for all types of motion for the total energy of the rocket. R.Li.

N67-14879# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**DETERMINATION OF POSITION FOR A SPACE VEHICLE**

K. M. Kaverznev *In its* Cosmic Res. 4 Aug. 1966 p 255–261 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

A mathematical discussion is presented on a method to determine the coordinates of a spacecraft on the basis of distances to that object measured from other known positions. From the coordinates of the measuring devices and the distances from them to the vehicle, the coordinates of the center of gravity for the base triangle and the square of the distance from the center of gravity to the vehicle are determined. The geocentric radius-vectors of the points are computed. The algorithm proposed makes it possible to obtain the coordinates of the space vehicle directly and efficiently in the given system by bypassing auxiliary transitions. R.Li.

N67-14880# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ORIENTATION IN INTERPLANETARY FLIGHT BY MEANS OF INSTRUMENTS BASED ON THE UTILIZATION OF RIGIDLY MOUNTED AND OPPOSITELY DIRECTED TELESCOPES**

A. D. Marlenskiy *In its* Cosmic Res. 4 Aug. 1966 p 262–266 ref (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

Problems of space-vehicle attitude in interplanetary space and the determination of their orbital elements may be resolved by means of instruments based on the utilization of two mutually fixed and oppositely directed telescopes. If one of the telescopes ($T_1$) is directed at the sun, the second telescope ($T_2$) will make possible observation of the stars on the opposite side of the celestial sphere. It is possible, on this basis, to devise a number of instruments, both automatic and controlled (in the latter case, where there is a cosmonaut aboard the vehicle). Author

N67-14919*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**EXPOSITION OF SUNDMAN'S REGULARIZATION OF THE THREE BODY PROBLEM**

Donald K. Yeomans Dec. 1966 113 p refs

(NASA-TM-X-55636; X-640-66-481) CFSTI: HC $3.00/MF $1.30 CSCL 22C

The equations of motion and the integrals of motion are derived. Double real collision is investigated and the vector joining the center of mass of the two colliding bodies and the non-participating third body is found to be bounded. The velocity and acceleration approach infinity as the distance between the two colliding bodies approaches zero. The unit vector approaches a limit near real collision. A new independent variable u is introduced which is seen to remove the singularity in the equation of motion for double collision. The mutual distances between the three bodies, along with the original independent variable are expanded into a power series in u. A lower limit for the strip of convergence of these solution series is determined. Another independent variable w is introduced and it is seen to remove all singularities for any number of double real collisions between any of the three bodies. A lower limit is also determined for the strip of convergence of the power series solution with respect to this variable. The convergence of the power series solutions is investigated and found to be extremely slow. Author

N67-15044# Mitre Corp., Bedford, Mass.

**ON THE MOTION OF AN ARTIFICIAL EARTH SATELLITE**

James B. Frazer Bedford, Mass., AFSC, Electron. Systems Div., Sep. 1966 58 p refs

(Contract AF 19(628)-5165)

(MTR-208; ESD-TR-66-293; AD-634315) CFSTI: HC $3.00/MF $0.75

The periodic position and velocity perturbations of an artificial earth satellite are developed to the first order for all Jn, based on the theory by Brouwer as extended by Giacaglia. An explicit formulation is also provided for the subset J2, J3, J4. The use of a position and velocity formulation circumvents the equatorial and circular orbit singularities found in conventional developments. The definition of the mean elements of the theory is modified to reduce the complexity of the position perturbations, as suggested by Mersons Theory, and the resulting changes to the secular terms are developed. In order to facilitate an empirical correction for drag, the observed mean motion is introduced as a mean element in place of the semi-major axis. Author (TAB)

N67-15061# Kapteyn Astronomical Lab., Groningen (Netherlands).

**R. S. OPHIUCHI: REDUCTION OF SPECTRA FROM THE 1958 OUTBURST Final Report**

C. R. Tolbert, J. C. Pecker, and S. R. Pottasch [1965] 39 p refs Submitted for Publication

(Contracts N62558-3644; N62558-3466; Grants Nonr(G)-00022-62; Nonr(G)-0001-60)

(AD-639747) CFSTI: HC $2.00/MF $0.50

Spectra taken at the 1958 outburst of R. S. Ophiuchi have been reduced to units of ergs/sq cm/sec/a and are presented as a function of time for the first month and a half after maximum. The Balmer decrement was constant during the first 3 weeks and agreed well with that found at the 1933 event. The hydrogen lines appeared cut-off on the violet in the early days and an absorption line with velocity around 4000 km/sec was indicated. Many narrow (< or = 1A) absorption and emission lines were noted, mostly from Fe. <OII>, <NII>, and <NeIII> were seen after about the 5th day. Intensities and half-widths are given for all the lines measured. Author (TAB)

N67-15075# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**EPHEMERIS CALCULATION OF THE ANGULAR VELOCITY OF A SATELLITE OF THE EARTH**
B. A. Firago 18 Apr. 1966 13 p refs Transl. into ENGLISH from Astron. Sovet (USSR), no. 32, 1963 p 3–7
(FTD-TT-65-861; TT-66-62413; AD-640248) CFSTI: HC $1.00/MF $0.50

Assuming the ephemeris position to be known, a method is proposed for calculating the topocentric angular velocity in accordance with the period of rotation and the geocentric radius vector of a satellite. The latter data can be found in accordance with observations at one separate station which were made on previous dates. Thus, the topocentric data of the movement of the satellite (mu, i, or 0) can be found at each station in accordance with completely accessible information. Author (TAB)

N67-15083# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
**A NECESSARY CONDITION FOR STABILITY OF ORBITAL MOTION**
K. V. Kholshevnikov 16 Aug. 1966 7 p refs Transl. into ENGLISH from Vestn. Leningr. Univ., Ser. Mat., Mekh. i Astron. (Leningrad), no. 1, 1966 p 172–173 refs
(Contract NOw-62-0604-c)
(TG-230-T486; AD-639907) CFSTI: HC $1.00/MF $0.50

Translation of Russian research: A Necessary Condition for Stability of Orbital Motion. TAB

N67-15091# System Development Corp., Santa Monica, Calif.
**GENERALIZED MULTISTEP METHODS AND APPLICATIONS TO SATELLITE ORBIT TRAJECTORY COMPUTATION**
James Dyer 28 Oct. 1966 67 p refs
(SP-2831; AD-642232) CFSTI: HC $3.00/MF $0.65

Recent ideas in the theory of multistep methods of solving a differential equation of the first order are extended to methods of solving the special second order equation y(double prime) = f(x,y). A slight modification of the usual multistep method permits a significantly higher order approximation of the difference equation to the differential equation without loss of stability. The method of constructing the generalized difference equation is based on a quasi-hermite polynomial approximation. An outline of this theory is given along with some related unsolved problems. This method permits the construction of new classes of stable difference equations with high order of accuracy for solving both a first order differential equation and the above special second order equation. Some of the new methods have been tested in experiments including the computation of an unperturbed satellite orbit trajectory. Machine time used and accuracy obtained are compared with a standard multistep method. Although further theoretical and experimental work remains to be done towards the analysis of accumulated round-off error and truncation error in the new methods, it is expected that they can eventually be incorporated into efficient algorithms for solving the general equations of motion of an earth satellite. Author (TAB)

N67-15172# Joint Publications Research Service, Washington, D. C.
**RESULTS OF EXPERIMENTS FOR DETECTION OF A LUNAR IONOSPHERE MADE ON THE FIRST LUNAR ARTIFICIAL SATELLITE**
K. I. Gringauz, V. V. Bezrukikh, M. Z. Khokhlov, G. N. Zastenker, A. P. Remizov et al 9 Jan. 1967 9 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 170, no. 6, 1966 p 1306–1309
(JPRS-39455; TT-67-30105)

Preliminary results are presented from an analysis of data obtained during the flight of Luna-10. The charged particle traps carried aboard the spacecraft for recording positive ions and low energy electrons are described, and the values measured in interplanetary space are shown. A number of effects occurring during the measurements which may have considerably exaggerated the results are also discussed. A.G.O.

N67-15213*# Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies.
**AN INITIAL VALUE PROBLEM FOR OSCILLATIONS OF THE INTERSTELLAR GAS**
I. Lerche and E. N. Parker Dec. 1966 29 p refs
(Grant NsG-96-60)
(NASA-CR-81125; EFINS-66-111) CFSTI: HC $3.00/MF $0.65 CSCL 03B

For a simple model of the interstellar gas-magnetic field system, in which the disk population of stars provides most of the gravity, it is demonstrated that a dispersion relation approach to the problem of small perturbations of the equilibrium state leads to unstable modes which possess a constant energy density at an infinite distance from the disk. Since one normally treats perturbations in which the energy density vanishes at infinity, rather than merely being bounded, we investigate an initial value problem in which the energy density does vanish at infinity. In one simple case it is shown that an unstable situation can still develop but that the perturbed quantities grow linearly with time, rather than exponentially as a normal mode analysis would indicate. It is further shown that one can still characterize the time scale for instability by the free-fall time so that conclusions drawn elsewhere remain valid. Author

N67-15266# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
**INVESTIGATION OF MOTION IN CISLUNAR SPACE USING THE VERY RESTRICTED FOUR-BODY MODEL**
Roger Leon Gounaud, Jr. (M.S. Thesis) Jun. 1966 76 p refs
(GGC/EE/66-9; AD-639696) CFSTI: HC $3.00/MF $0.75

A procedure is developed for determining periodic cislunar trajectories in the very restricted four-body problem. The two initial conditions, velocity and position, are varied to satisfy the periodicity criteria. Two types of trajectories are presented, a retrograde trajectory for which a set of initial conditions was found that satisfies the requirements and a direct trajectory for which a suitable set of initial conditions could not be found that satisfied the periodicity criteria. Problems in numerical procedures near the singularities must be solved before more accurate results can be obtained. Author (TAB)

N67-15280*# RAND Corp., Santa Monica, Calif.
**A NUMERICAL GENERAL CIRCULATION EXPERIMENT FOR THE ATMOSPHERE OF MARS**
C. B. Leovy and Y. Mintz Dec. 1966 48 p refs
(Contract NASr-21)
(NASA-CR-81146; RM-5110-NASA) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A numerical model for simulating the general circulation of the atmosphere of Mars is described and preliminary results from an initial experiment are given. The experimental conditions correspond to the Northern Hemisphere winter solstice on a planet, in the orbit of Mars, having an atmosphere composed entirely of $CO_2$ and an initial surface pressure of 5 mb. The important features indicated by the model are development of a fluctuating wave regime in the winter hemisphere, a large amplitude diurnal tide, and condensation of $CO_2$ to form a winter polar ice-cap. The preliminary character of this experiment is stressed and some future improvements are proposed. Author

# 31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

**N67-14435*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**THE EFFECT OF THE GAS LEAK ON THE PIONEER VI ORBIT, PART II**
J. E. Ball *In its* Space Programs Sum. No. 37-41, Vol. III 30 Sep. 1966 p 62-67 ref (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

The effects of the observed Pioneer VI gas leak on its orbit are analyzed and traced. For this analysis, the tracking data were obtained from March 1 to June 20, 1966. It is concluded that the gas leak, while diminishing, is still significantly affecting the spacecraft orbit determination. R.N.A.

**N67-14557*#** General Dynamics/Convair, San Diego, Calif.
**RANGE SAFETY AERODYNAMICS DATA FOR ATLAS/CENTAUR/SURVEYOR DIRECT ASCENT FLIGHTS**
T. Chacon 4 May 1966 42 p refs
(Contract NAS3-8701)
(NASA-CR-80892; GD/C-BTD-66-034) CFSTI: HC $2.00/MF $0.50 CSCL 22D

Atlas/Centaur/Surveyor range safety aerodynamics data are presented. Nominal impact points and impact dispersion envelopes are given for the Atlas booster and sustainer stage and for the Centaur insulation panels and nose fairing. Impact information covers the full range of trajectories targeted for the AC-10 launch opportunities. Supplemental data are presented to extend the range of launch azimuths to 80 deg. To support a detailed analysis of the effects of destruct action or premature flight termination, applicable drag coefficients and vehicle fragmentation data are presented. In accordance with range safety requirements, results of an investigation of the possible number of resulting fragments and a drag and velocity analysis for fifteen of the major fragments are given. Power-off drag coefficients for various stage combinations are presented to support an analysis of the effects of premature flight termination. The impact data presented in this report were derived from trajectories targeted for the AC-10 vehicle, but the results are applicable for all direct ascent missions of Atlas/Centaur/Surveyor. Author

**N67-14792*#** General Electric Co., New York.
**DESIGN CRITERIA FOR TYPICAL PLANETARY SPACECRAFT TO BE STERILIZED BY HEATING**
Ronald G. Crawford (NASA Marshall Space Flight Center) and Richard J. Kepple *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 473-501 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50
(Contracts NAS8-11107; NAS8-11372)

Work is described which was performed to establish guidelines for the design of planetary spacecraft subject to heat sterilization. The concept of heat sterilization within a sealed sterilization barrier was rigidly followed. Because of uncertainities regarding actual requirements, a conservative range of environments was specified which extended from a maximum of 150°C for 60 hours to a minimum of 135°C for 24 hours. Analytical and test phases were designed to present solutions to sterilization problems where possible and to define problems better where solutions are not readily available. Primary emphasis was placed on the response of structural and mechanical components to high temperatures. R.N.A.

**N67-14793*#** National Aeronautics and Space Administration, Washington, D. C.
**STERILIZATION OF SCIENTIFIC PAYLOADS FOR PLANETARY EXPLORATION**
Carl W. Bruch *In its* Spacecraft Sterilization Technol. 1966 p 503-514 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

A brief description is given of the methods employed in the selection of scientific payloads for planetary missions. An analysis has been made of the sterilization problems facing experimenters in connection with several instruments that could be included in a planetary-landing scientific package. The solutions to these problems have been discussed rather briefly, but enough detail has been presented so that others working on similar problems will know where to obtain the best available information. Author

**N67-14797*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**PLAN FOR STERILIZATION OF VOYAGER CAPSULE**
Gordon P. Kautz, Paul Tarver (NASA, Washington) et al *In* NASA, Washington Spacecraft Sterilization Technol. 1966 p 559-573 (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

An operational plan is outlined for the manufacture and testing of Voyager capsules that will result in flight capsules that can be certified to meet sterility requirements and that have demonstrated reliability. Flight acceptance, verifying operations, flight acceptance testing, and ethylene oxide decontamination aspects of the plan are discussed. R.N.A.

**N67-14799*#** General Dynamics/Convair, San Diego, Calif.
**FLIGHT-WIND RESTRICTIONS PROCEDURE, ATLAS/CENTAUR AC-10 THROUGH AC-15. ADDENDUM I: BACK-UP PROCEDURE**
J. A. Traband 29 Apr. 1966 34 p refs
(Contract NAS3-8701)
(NASA-CR-80919; GDC-BTD66-063) CFSTI: HC $2.00/MF $0.50 CSCL 22D

A backup procedure is presented for rapidly evaluating wind profiles shortly before launch in the event of a communications breakdown between San Diego and Cape Kennedy. The backup method uses an IBM 1401 computer, or desk calculator, and gives slightly conservative results. Bending moments at three vehicle stations are possibly critical. Therefore, allowable values are compared with calculated values to determine a launch recommendation. Engine deflection is ignored in this procedure since bending moment loads are almost always more critical. R.N.A.

**N67-14876#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**MAGNETOMETRIC EQUIPMENT ABOARD THE "ELEKTRON-2" SPACE STATION**
L. M. Aleksanyan, Ye. G. Yeremenko, L. N. Zhurgov, and U. V. Fastovskiy *In its* Cosmic Res. 4 Aug. 1966 p 208-223 refs (See N67-14881 05-30) CFSTI: HC $6.00/MF $1.50

A description is presented of two three-component ferrosonde magnetometers of varying sensitivity, mounted aboard the "Elektron-2" satellite. Metrological characteristics of the apparatus are presented, as is an evaluation of the errors in the measurements of the terrestrial magnetic field at distances from 3 through 11.67 $R_e$. Author

**N67-14883*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**MARINER MARS 1964 HANDBOOK**
Robert Van Buren 1 Dec. 1965 199 p
(Contract NAS7-100)
(NASA-CR-80953; JPL-TM-32-265) CFSTI: HC $3.00/MF $2.80 CSCL 22B

A compilation of significant technical data relative to Mariner Mars 1964 is presented. The information presented pertains primarily to the Mariner spacecraft itself; it does not include the launch vehicle system, the ground support equipment, the deep space network system, or other areas of the total Mariner Mars 1964 project. The primary Mariner Mars 1964 mission is considered to have ended on October 1, 1965. Historical data are carried only to that date, although some orbital parameters are projected to 1967 and 1971 in the tables and figures. A list of documents pertaining to the Mariner Mars 1964 mission is included for reference purposes. Author

N67-14901*# North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.

**MECHANICAL IMPACT SYSTEM DESIGN FOR ADVANCED SPACECRAFT (MISDAS)**

A. I. Bernstein 13 May 1966 400 p

(Contract NAS9-4915)

(NASA-CR-65563; SID-66-409) CFSTI: HC $3.00/MF $3.90 CSCL 22B

Guidelines, design requirements, performance criteria, soil conditions, and material properties for the Mechanical Impact System Design for Advanced Spacecraft, MISDAS, are presented. In phase I, of the study, preliminary design, stability, and structural evaluations of candidate design concepts were conducted. Two concepts, a six-legged segmented heat shield, and an extended aft heat shield with 12 radially deployed skids, were selected for optimization. In phase II, preliminary design and structural and stability analyses were performed to obtain the weight and volume required to apply MISDAS to a 14,000 lb spacecraft. Major structural and landing system components were sized; and tradeoff analyses determined that both landing systems were stable for the design conditions but required crew attenuation systems for vertical landing velocities above 15 fps; and that roll control of the spacecraft during landing is needed when effective ground coefficients of friction above 0.35 are encountered. Other aspects of the study, such as the computer programs developed to calculate and record the spacecraft motion after ground contact, are also discussed. L.S.

N67-14902*# Boeing Co., Seattle, Wash. Space Div.

**PRELIMINARY PROGRAM PLAN AND COST FOR THE MANNED ORBITAL TELESCOPE (MOT)**

[1966] 117 p

(Contract NAS1-3968)

(NASA-CR-66256; D2-84042-3) CFSTI: HC $3.00/MF $1.30 CSCL 22B

Industrial data was obtained from a survey made of related industries. The report is organized around the three basic functions of program planning, facility planning, and cost estimation. The program planning includes task descriptions, sequencing; and scheduling; and the facility planning consists of identifying the significant MOT unique requirements. Costs associated with this planning are prepared for the basic MOT system but do not include logistic and space station system costs. Author

N67-14908*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

**THE ALLEVIATION OF AERODYNAMIC LOADS ON RIGID SPACE VEHICLES**

Mario H. Rheinfurth 21 Feb. 1966 42 p refs

(NASA-TM-X-53397) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The study demonstrates how the control systems engineer can assist in the task of maintaining stability of a space vehicle through atmospheric disturbances at all flight times by a judicious choice of the control system parameters. To this effect, several typical control modes are analyzed for some basic wind profiles. The extent to which a reduction of aerodynamic loads and control excursions can be expected is discussed for various wind, wind shear, and gust conditions. By restricting the analysis to planar and linearized motion of the vehicle, it is possible to derive a set of preliminary design rules, which allows one to predict the relative merits of the discussed control principles when system parameters or wind structure is changed. In addition, the study provides monograms for the quick determination of gain settings for accelerometer-controlled vehicles if the gain values are given for angle-of-attack control and vice versa. Author

N67-14910*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

**ORBITAL INVESTIGATION OF PROPELLANT DYNAMICS IN A LARGE ROCKET BOOSTER**

H. J. Buchanan and F. M. Bugg 1 Dec. 1966 28 p refs

(NASA-TM-X-53542) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Experimental data on the dynamics of liquid hydrogen in the 6.6 m diameter tank of an S-IVB stage during boost, at S-IVB stage cutoff, and in orbit are presented. For the boost phase of flight, the amplitude of the sloshing liquid decreased from approximately .25 m at the beginning of S-IVB stage boost to a minimum of about .038 m as the liquid level moved past the baffle. The frequency during the S-IVB stage engine burn increased from approximately .44 cycles per second to .70 cycles per second and showed good agreement with predicted values. During orbital coast, periods of the liquid hydrogen oscillation were measured through a range of accelerations. Period data taken while the acceleration was varying with time did not agree with either the predicted natural or coupled periods. Nearly steady-state conditions existed for the $8.0 \times 10^{-5}$ $g_0$ acceleration and the 300 sec to 330 sec slosh periods measured at this acceleration were close to the predicted value of 315 sec. Author

N67-14911*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**MICROBIOLOGICAL BURDEN ON THE SURFACES OF THE AIMP SPACECRAFT, PART 1**

Edmund M. Powers May 1966 16 p ref

(NASA-TM-X-55628; X-624-66-342) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The Anchored Interplanetary Monitoring Platform (AIMP) spacecraft was decontaminated and monitored for microbiological contamination during the first stage of assembly. The decontamination procedure, using isopropyl alcohol, resulted in a two-log reduction in the microbial population. Extrapolation and projection of the counts obtained to the completely assembled spacecraft indicated that the total spacecraft would have a population of $1 \times 10^7$ viable organisms before decontamination, and $2.8 \times 10^5$ viable organisms after decontamination. Author

N67-14934*# National Aeronautics and Space Administration, Washington, D.C.

**THIS NEW OCEAN. A HISTORY OF PROJECT MERCURY**

Loyd S. Swenson, Jr., James M. Grimwood, and Charles C. Alexander 1966 694 p refs

(NASA-SP-4201) GPO: HC $5.50; CFSTI: MF $7.15 CSCL 22B

A detailed account is given of the managerial and technological history of Project Mercury. Preliminary progress in rocketry and research in space medicine, aerodynamics, and thermodynamics from the end of the Second World War to the inception of the first U.S. manned satellite project is recounted emphasizing the contributions of individual minds and small groups of experimentalists. The technological and managerial aspects of Project Mercury are related, including organizing, contracting, innovating, manufacturing, training, and testing, giving insight into the enormity and intricacy

of modern government-managed technological programs. The fulfillment of Project Mercury is described, beginning with the suborbital flight of astronaut Alan B. Shepard, Jr., proceeding through the completion of the orbital qualification of the Mercury spacecraft and the Atlas rocket, and ending with the four manned orbital missions. Details are given on the functional organization of Project Mercury, workflow organization, flight data, cost summaries, and tracking net, and an extensive bibliography is included. L.E.W.

N67-14939*# North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.

**MECHANICAL IMPACT SYSTEM DESIGN FOR ADVANCED SPACECRAFT (MISDAS). APPLICATION TO AES SPACECRAFT**

A. I. Bernstein 25 Mar. 1966 205 p refs

(Contract NAS9-4915)

(NASA-CR-65562; SID-66-106) CFSTI: HC $3.00/MF $2.60 CSCL 22B

The primary objective of this study is the preliminary design of a mechanical impact attenuation system for earth landing of advanced Apollo-type spacecraft. The system is to be adaptable to Apollo with minimum modification, and must absorb landing impact, protect crew and structure from excessive forces, prevent overturning of the spacecraft, and permit spacecraft reuse with minor refurbishment. This document presents the results of a study of the feasibility of incorporating the mechanical impact system in the AES spacecraft. Design layout studies, structural analyses, landing stability analyses, and manufacturing evaluations were performed. Two concepts were considered—one using a deployed aft heat shield and radial skids, the other employing a hinged segmented heat shield. Incorporation of either system is potentially feasible. A preliminary development and qualification program is presented. Author

N67-14993# Space-General Corp., El Monte, Calif.

**AERODYNAMIC AND FLIGHT PERFORMANCE ANALYSIS FOR THE NIRO SOUNDING ROCKET, APPENDIX A**

James P. Taylor and Alvin M. Olson Mar. 1966 140 p refs

(Contract AF 19(628)-5520)

(SGC-916FR-1, Append. A; AFCRL-66-460(A); AD-641676) CFSTI: HC $5.00/MF $1.00

Contained in the report are the results of systematic calculations of the NIRO vehicle performance capabilities. These capabilities were determined by computing the vehicle trajectory characteristics for various payload weights and configurations. Trajectory parameters are presented as time-histories of velocity, altitude, range, flight path angle, Mach Number, and dynamic pressure. From these data, summary curves are provided giving velocity and altitude at major time points (i.e., stage ignition, burnout, and apogee) as a function of payload weight, and plots showing apogee altitude and impact range as a function of payload weight and launch angle (with constant apogee time lines). A set of data are given for each payload configuration. Also, included for information, are the vehicle weight, propulsion, and drag data used in these computations. Author (TAB)

# 32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N67-14458*# Measurement Analysis Corp., Los Angeles, Calif.

**DYNAMIC CHARACTERISTICS OF SQUARE PLATES BY PASSIVE ANALOG SIMULATION**

R. L. Barnoski Washington, NASA, Jan. 1967 52 p refs (Contract NAS8-20020)

(NASA-CR-666) CFSTI: HC $2.50/MF $0.50 CSCL 20K

This report considers the derivation and illustrates the use of a passive analog circuit to investigate dynamic properties of square plates. Two basic studies are conducted: The effect of boundary bending flexibility on the fundamental modal frequency for both uniform and tapered geometry, and the effect of edge dampers and a uniformly distributed loading on the frequency response characteristics of a uniform square plate. The results of these two studies are displayed as plots and charts based upon data obtained from the passive analog computer. The analog circuit employs mobility concepts and is derived essentially by equating the strain energy and kinetic energy associated with the lateral vibration of an arbitrary rectangular plate to the energy of the analog circuit. The resultant analog circuit can be applied to any rectangular plates with nonuniform physical properties, with arbitrary boundary conditions, and with any arbitrary deterministic and/or random loading. Author

N67-14477*# Swedish Forest Products Research Lab., Stockholm.

**STRESS RELAXATION IN HIGH POLYMERS AND METALS**

Josef Kubat *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 281–297 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

The process of stress relaxation in uniaxial extension in a number of high polymers and metals has been studied experimentally. Special attention has been devoted to a peculiar similarity in the shape of the relaxation curves relating to various materials. It has been observed that the maximum slope of the relaxation curve, when plotted in a stress-log time graph, is proportional to the total stress dissipation. At room temperature the constant of proportionality is in the vicinity of 0.1. It may change slightly when the straining time or the initial stress is varied. Its relationship to temperature is not known exactly. To a first approximation it may be considered as independent of temperature. The initial and final stages of the relaxation curves are usually dependent on the experimental conditions and on the properties of the specimen under investigation. The findings relate largely to room temperature. The main variables examined were initial stress (strain) and the rate of extension. The highest rate of strain was 5, the lowest $42 \times 10^{-5}$ sec.$^{-1}$. The initial extension covered the range from $5 \times 10^{-5}$ upward. The straining time was varied between 1 msec. and 100 sec. The devices used for the stress measurements (inductive pickups) were designed for the smallest possible deflection of the stress-sensing component. Author

N67-14478*# Rheinisch-Westfälische Technische Hochschule, Aachen (West Germany).

**MATERIAL RELAXATION AND STRUCTURAL DAMPING**

J. Meixner *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 299–316 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

Linear viscoelastic materials are described by an operational stress-strain relation. But they are always part of a system. What one measures is therefore the response of a structure built up from viscoelastic materials under certain applied stresses or forces. The relation between the material properties and the properties of structures is examined for some characteristic examples. First, it is shown how the theory of linear passive systems can be generalized to the case where stimulus and response are vector-valued functions. Then a characterization of the admittance functions of viscoelastic materials is tried. The reciprocity theorem for elastic materials is generalized to arbitrary inhomogeneous and anisotropic materials with

any type of loss under the only assumptions that the equations are linear and that the boundary conditions are of a certain type which is, however, frequently met. Finally, it is shown by the example of longitudinal motion of a rod, which is under the influence of a force on one end, under what conditions the displacement of this endpoint is given by the operational stress-strain relation of the material itself with neglect of the dynamic properties of the rod. Author

**N67-14483*#** Johns Hopkins Univ., Baltimore, Md.
**RATIONAL MECHANICS OF DEFORMATION AND FLOW**
C. Truesdell *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 3–30 Sponsored in part by NSF (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

Concepts of material response are expressed as statements of invariance embodying physical ideas directly. The constitutive equation for an ideal material satisfies the following principles: determinism, local action, and indifference. Most studies concern simple materials, such that a sufficient number of experiments of homogeneous strains determine their response to every deformation process. The concept of material isomorphism expresses the idea that two particles consist of the same material. If a nonidentical deformation is an isomorphism of a particle with itself, no subsequent experiment can detect whether that deformation has occurred or not. The isotrophy group of material consists of those deformations which do not alter the apparent physical properties. Two applications are discussed. First, if each particle is materially isomorphic to each other one, the body is materially uniform but need not be homogeneous. For such a body, the continuum theory of dislocations is shown to follow directly. Second the entire theory of viscometric measurements in simple fluids follows directly from the physical definition of those fluids. Author

**N67-14485*#** Washington Univ., Seattle. Dept. of Aeronautics and Astronautics.
**A THEORY OF PHOTOTHERMOVISCOELASTICITY**
Ellis Harold Dill *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 51–59 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

This paper provides a theoretical basis for the determination of the state of plane stress in a viscoelastic model by observation of the fringe pattern. It is found that under certain hypotheses the time history of birefringence and the time history of the axis of polarization completely determine the difference in principal stresses and the principal axes of the stress tensor. Author

**N67-14486#** Yale Univ., New Haven, Conn.
**FINITE EXPANSION OF A SPHERICAL CAVITY IN A LOCKING MEDIUM**
Aris Phillips and Chang-Tsan Sun *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 61–76 refs Sponsored by NSF (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

The theory of locking media is extended to finite strains and the problem of finite expansion of a spherical cavity in a locking medium is solved. The locking conditions of limited change of volume and of a neo-Hookean medium are used and the results are compared with the solution of the same problem for infinitesimal strains. Author

**N67-14488*#** Picatinny Arsenal, Dover, N. J. Polymer Research Section.
**SOME PROBLEMS IN NONLINEAR VISCOELASTICITY**
J. L. Davis *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 95–107 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

A first-order nonlinear one-dimensional theory of viscoelasticity has been constructed using an elementary perturbation method. Small nonlinearities have been introduced in the elastic and viscous elements. The models are single and coupled Voigt and Maxwell with and without mass. The response of a nonlinear Voigt model to a sinusoidally applied stress is governed by a nonlinear complex modulus. The extension to coupled systems involves complex compliances or moduli that are the sums of those of the individual elements. Author

**N67-14489*#** Purdue Univ., Lafayette, Ind.
**SMALL DEFORMATIONS SUPERPOSED ON AN INITIAL LARGE DEFORMATION IN VISCOELASTIC BODIES**
George Lianis *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 109–119 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00
(Contract AF 04(611)-8539)

Constitutive equations of viscoelastic bodies with fading memory have been derived for small dynamic deformation superposed on an initial static large deformation. The derivation starts from the constitutive equation of Coleman and Noll. After superposing the small dynamic deformation the resulting expression is linearized in the superposed displacement gradients. The constitutive equation thus derived is linear in the superposed strain, and resembles the integral stress–strain equations of linear viscoelasticity. While the latter is expressed in terms of two relaxation functions, the former is defined in terms of twelve relaxation functions of time and the invariants of the initial deformation. In addition the strain of the initial deformation enters in the constitutive equation in a nonlinear manner. By a formal tensor transformation, the contravariant stress as a convected system of coordinates has been obtained in terms of the history of the covariant (small) strain and the metrics of Coleman and Noll and undeformed configuration. Author

**N67-14491*#** Catholic Univ. of America, Washington, D. C.
**INERTIA EFFECTS IN THE TENSILE STRESS RELAXATION TEST**
J. H. Baltrukonis and James H. Thacher *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 151–166 ref (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00
(Contract NOrd-16840)

The general theory is specialized to a two-parameter Maxwell model and solved by the Laplace transform method. A series of plots was prepared showing the effect of rise time of the ramp end-displacement program and the relaxation time of the material on the stress response. In all cases, the stress transient persists beyond the time required for the quasi-static stress solution to become vanishingly small. Author

**N67-14492*#** Armstrong Cork Co., Lancaster, Pa.
**ON THE SPHERICAL INDENTER AS A MEANS FOR DETERMINING VISCOELASTIC MATERIAL FUNCTIONS**
I. G. Nolt and J. A. Meier *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 167–181 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

The application of finite difference integration for the determination of material response functions was investigated and its application demonstrated. As distinguished from alternate methods of solution this procedure requires no analytic formulation of the problem or the need for instantaneously performed experiments. For this particular case satisfactory stability has been shown to depend upon the interval spacing and the loading function form. In general, increasing the geometric ratio of successive time intervals attenuates more rapidly the contributions and any implicit errors of the previously computed values in the algorithm.

However, associated with an increase in the spacing ratio are increased interval lengths which at some point could introduce appreciable error as a consequence of the mean value approximation. Author

**N67-14494*#** Catholic Univ. of America, Washington, D. C.
**CREEP BENDING OF A BEAM-COLUMN OF A VISCOELASTIC MATERIAL GOVERNED BY AN INTEGRAL OPERATOR TYPE OF CONSTITUTIVE LAW**
J. H. Baltrukonis and Ramesh N. Vaishnav *In* Brown Univ. Proc. of the 4th Inter. Congr. on Rheol., Pt. 2 1965 p 195–211 refs Sponsored by Hercules Powder Co. (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

The problems of finding deflections of a beam column of a viscoelastic material whose behavior is represented by an integral operator type of stress–strain relation is solved by reducing the governing integrodifferential equation to a set of sequentially solvable ordinary differential equations, and solving the latter by two methods. Numerical results based on the first, the finite difference method have been presented for a three-parameter Voigt material, and are compared with those obtained using a differential operator type of representation. Exact solution of the set of differential equations constitutes the second method. In this case only the solution has been given; no numerical example has been given, as the approach is rather straightforward. Author

**N67-14495*#** Stanford Univ., Calif.
**ON THE INFLUENCE OF VISCOELASTIC COMPRESSIBILITY IN STRESS ANALYSIS**
N. C. Huang, E. H. Lee, and T. G. Rogers *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 213–229 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00
(Contract Nonr-225(69))

Since more precise measurements of dilatational response can be expected, certain solutions of viscoelastic stress analysis problems are presented to illustrate the convenience of utilizing measured relaxation moduli in dilatation as well as shear in evaluating stress distributions. Examples for cylindrical boundaries are given. These solutions are also useful in suggesting experimental configurations from which the relaxation modulus in dilatation can be deduced. Author

**N67-14496*#** Du Pont de Nemours (E. I.) and Co., Wilmington, Del. Engineering Technology Lab.
**NONLINEAR VIBRATION OF A VISCOELASTIC STRING**
D. W. Oplinger *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 231–245 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

The transverse forced vibration of a nylon monofilament is considered under conditions that cause stretching and tension changes in the string. An appropriate stress–strain law for the problem is developed in terms of a three-element viscoelastic model whose parameters are determined from stress relaxation measurements on the monofilament. A simplification occurs because the model is assumed to be operating considerably above its relaxation frequency. Because of the tension changes, the resulting vibration is nonlinear. Solutions to the equation of motion are obtained through an approach previously applied to a perfectly elastic string. Theoretical results in terms of measured curves of tension variation versus frequency are discussed. Author

**N67-14497*#** California Univ., Berkeley.
**THERMAL CYCLING OF A VISCOELASTIC ROD**
R. L. Taylor and K. S. Pister *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 247–259 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

The problem considered is that of a prismatic rod undergoing changes in temperature. In particular, the cumulative effect of periodic thermal cycling on a linear viscoelastic rod whose thermomechanical behavior satisfies the time–temperature equivalence hypothesis is examined. As an example, numerical results are shown for a clamped rod with Maxwell-type mechanical response. Author

**N67-14498*#** Purdue Univ., Lafayette, Ind.
**WAVE PROPAGATION IN VISCOELASTIC SOLIDS WITH MEASURED RELAXATION OR CREEP FUNCTIONS**
K. C. Valanis *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 261–285 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00
(Contract AF 94(611)-8539)

In particular, the following two problems are considered: (1) propagation of a plane wave in a semi-infinite viscoelastic rod, and (2) propagation of a cylindrical wave emanating from a cylindrical cavity of finite radius. Author

**N67-14499*#** Brown Univ., Providence, R. I.
**THE USE OF SIMPLE VISCOELASTIC MODELS IN STRESS ANALYSIS**
C. R. Arnold, E. H. Lee, and J. Panarelli *In its* Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 287–299 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00
(Grant DA-ARO(D)-31-124-G-367)

While it is known that most polymeric materials exhibit a broad spectrum of relaxation or delay times, only a narrow band of response may be stimulated in a particular loading situation. For such a case, a simple viscoelastic model representation of the material response may be satisfactory for stress analysis. The model then represents the material characteristics as they influence the response to this history of loading, and a different model would in general be needed for the same material subjected to another load variation. A simple example of the use of a four-element model is discussed with suggestions on choice of the appropriate model. The application of a simple model representation can often greatly simplify stress calculations. Author

**N67-14501*#** Minnesota Univ., Minneapolis.
**STRESS ANALYSIS OF AN ANISOTROPIC VISCOELASTIC HOLLOW CYLINDER**
S. R. Moghe and C. C. Hsiao *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 321–340 refs Sponsored in part by AEC (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

Elementary solutions of stress analysis problems for an anisotropic linear viscoelastic hollow cylinder are given and extended to a particular nonhomogeneous anisotropic viscoelastic case. In order to reduce some of the mathematical difficulties, assumptions are made that the strains are small and all the analyses are considered quasi-static plane strain problems with axial symmetry. Numerical results for both short-time and long-time behavior are presented for a mathematically simple model medium and compared with that for the isotropic material medium. Author

**N67-14505*#** Brown Univ., Providence, R. I.
**ANALYSIS OF PEELING**
C. Mylonas *In its* Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 423–447 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

Fundamental relations are established between the applied forces at the end of a peeled strip and the stresses in an idealized elastic adhesive. These relations are specialized first for an elastic perfectly-plastic peeled strip and later for an elastic strip. The elastic–plastic solution shows a qualitative correspondence with

experimental results of 90°-peeling, which give a maximum peeling force at an intermediate strip thickness. The strip-back and climbing-drum tests, and the requirements of an ideal peeling test are discussed. The results of the elastic solution indicate that several effects observed with soft adhesives are due to viscoelastic flow. Author

**N67-14506*#** American Cyanamid Co., Stamford, Conn. Central Research Div.

**THE RHEOLOGY OF STRESS CRAZING**

Robert E. Coulehan *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 449–464 refs (See N67-14581 05-34) CFSTI: HC$10.34/MF$3.00

The presence of particular classes of liquids induces crazings and subsequent fracture in certain types of stressed polymers. The development of crazes into cracks and fracture of bars of poly(methyl methacrylate) is followed by changes in birefringences by high speed photography. Differences in the morphology of the fracture surface are examined with both the light and electron microscope. A rheological mechanism is proposed to account for the crazing phenomenon. Data are introduced showing the effect of molecular weight and molecular weight distribution on the time to craze fracture. Author

**N67-14522*#** Bergakademie Clausthal-Technische Hochschule, Clausthal-Zellerfeld (West Germany). Institut fuer Theoretische Physik.

**HOW THE INTERNAL STATE OF A PLASTICALLY DEFORMED BODY IS TO BE DESCRIBED IN A CONTINUUM THEORY**

E. Kroener *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 3–9 refs (See N67-14521 05-34) CFSTI: HC$6.87/MF$2.50

The internal state of a plastically deformed body is determined by its dislocation arrangement. This can be described in a macroscopic way by forming dislocation moments. A new material law gives the change of the moments under an increment of plastic strain. The amount of work to be done for the moments must be taken into consideration. For simple path loads the first moment alone might lead to a good approximation. Author

**N67-14523*#** Turin Univ. (Italy). Chemical Inst.

**RECOVERABLE SHEAR STRAIN AND THE ELASTICITY NUMBER**

C. Musso and P. Sacerdote *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., pt. 3 1965 p 11–14 refs Prepared jointly with Montecatini S.p.A. (See N67-14521 05-34) CFSTI: HC$6.87/MF$2.50

The elasticity number and the recoverable shear strain are related through simple analytical considerations. It was found that when practical data can be compared, the quantitative agreement is good. Author

**N67-14524*#** Farbenfabriken Bayer, A. G., Leverkusen (West Germany). Abteilung Angewandte Physik.

**A SYMMETRIC FORMULATION OF THE LINEAR THEORY OF VISCOELASTIC MATERIALS**

Hanswalter Giesekus *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 15–28 refs (See N67-14521 05-34) CFSTI: HC$6.87/MF$2.50

In the linear theory of viscoelastic materials, the two basic functions, inverse with respect to each other, of creep compliance and relaxation modulus as well as their Carson transforms, i.e., complex compliance and complex modulus, are usually introduced and the behavior of the various materials is described. It is pointed out that in doing so certain relations of reciprocity that exist between the different classes of materials with respect to commuting stress and strain history are suppressed. It is stated that a perfectly symmetric formulation of the theory is arrived at if two additional basic functions, i.e., stressing viscosity and retardation fluidity, as well as their Carson transforms, complex viscosity and complex fluidity, are introduced. The development of this theory from the deductive theory of linear dissipative systems, is also discussed. Author

**N67-14527*#** Bucharest Univ. (Rumania).

**DYNAMIC STRESS WAVES IN VISCOELASTIC PLASTIC BODIES**

N. Cristescu and M. Predeleanu (Math. Inst., Acad. R. P. R.) *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 79–93 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF$2.50

A constitutive relation is used in which instantaneous elastic, retarded elastic, and plastic effects are present. First, the principal static properties of such a body are briefly summarized. Next, the dynamic behavior of the body is illustrated by a one-dimensional problem. For that, two methods, numerical and operational, are used. The boundary of the viscoelastic plastic domain is determined, as well as the distribution along the bar of the stress, strain, and velocity. The three-dimensional constitutive law is discussed. Author

**N67-14528*#** Ecole Polytechnique, Paris (France).

**TRACTION AND TORSION TESTS ON TUBES AND METAL WIRES [ESSAIS DE TRACTION ET TORSION SUR TUBES ET FILS METALLIQUES]**

J. Mandel, P. Habib, and H. D. Bui *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 97–117 In FRENCH (See N67-14521 05-34) CFSTI: HC$6.87/MF$2.50

A comparison is made between the various theories proposed to relate deformations and constraints of plastic properties. Consideration is given to tubes or tractable wires with a force exceeding the limits of elasticity, with a torque of growing torsion. In one set of tests the force was constant while the torque increased; in the other tests the length was constant. For the first type, deformation theories were found to be incorrect, but the discharge theories gave good results. The second type testing gave good results between two discharge theories. A third series of tests directly confirmed the existence of a plastic potential by verifying a reciprocity theorem. M.W.R.

**N67-14560*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

**ON DYNAMIC RESPONSE OF A RECTANGULAR PLATE TO A SERIES OF MOVING LOADS**

Frank C. Liu 29 Aug. 1966 45 p refs

(NASA-TM-X-53506) CFSTI: HC$2.00/MF$0.50 CSCL 20K

The effect of a series of evenly spaced moving loads on an elastic rectangular plate that was clamped at all edges was examined. Two types of loads were treated: (1) a uniformly distributed pressure over a fractional length of the plate and (2) an impulsive load. All loads across a plate were considered uniform. The solution of the partial differential equation of vibration of a plate was assumed in the form of a double series with the generalized coordinates solved by using the Laplace transform method. Viscous damping was included. Based on a two-term approximation, the steady-state dynamic response of the plate was obtained in analytical form from which the upper bounds of the maximum deflection and maximum bending stress were formulated. Numerical examples are given to illustrate the effect of the thickness of the plate, the aspect ratio, and the velocity of loads on the dynamic response. Three types of resonance conditions were derived. Author

N67-14839# Aeronautical Research Council (Gt. Brit.)
**THE INTERPRETATION OF STRAIN MEASUREMENTS FOR FLIGHT LOAD DETERMINATION**
P. B. Hovell, D. A. Webber, and T. A. Roberts Aug. 1964 36 p refs Supersedes RAE-TN-STRUCT-363; ARC-26659; see X67-12982
(ARC-CP-839; ARE-TN-STRUCT-363; ARC-26659) CFSTI: HC $2.00/MF $0.50

The procedures of NACA for the interpretation of measured flight strains as structural loads were found to be not entirely satisfactory when applied to delta or slender-body configurations due to the severe non-linearities in the gauge response with the position of the calibrating load and the need to support the aircraft representatively during ground calibrations. To overcome these difficulties, distributed load data, obtained either directly or by superposition, were used in place of individual load data. This procedure establishes directly the reliability of any particular flight load measurement. Laboratory tests on an aircraft fin showed that the modified method interpreted the strain measurements at a chordwise section as net bending movements, torques, and shears within ±3% at the 67% confidence level. K.W.

N67-14857# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**METHOD OF TESTING ACTUAL SPECIMENS AND PANELS OF AIRPLANE SKIN FOR RESISTANCE TO VIBRATION**
M. F. Astakhov and B. N. Yavdokimov 18 Apr. 1966 8 p Transl. into ENGLISH from Russian Patent no. 164453 (Appl. no. 849751/40-23, 27 Jul. 1963) 2 p
(FTD-TT-65-1742; AD-640305) CFSTI: HC $1.00/MF $0.50

The object of the invention is a method of testing actual specimens and panels of airplane skin for vibration resistance in a shell with a propeller-engine unit. The tested parts and the panels of the airplane skin are arranged in rows in ring fashion on frames, fastened on the walls of the channel of a shell at a given distance from the ends of the blades and are subjected to the action of vibration from the propeller. The vibration stress is measured by strain gages fastened on elements of the skin and connected by screened wire with the measuring equipment. TAB

N67-14879# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**MOVEMENT OF THE TWO PARTS AFTER THE BURSTING APART OF A VOLUME WITH GAS IN A VACUUM**
G. L. Grodzovskiy and F. A. Kukanov 30 Mar. 1966 13 p refs Transl. into ENGLISH of the publ. "Dvizheniye Dvukh Chastey Posle Razryva Ob'yema s Gazom v Vakuume" 1965 11 p
(FTD-TT-65-1675; TT-66-62420; AD-640256) CFSTI: HC $1.00/MF $0.50

A solution is given to the problem of the movement, in a forceless field, of the two parts formed from a gas-filled container which has burst in a vacuum environment. TAB

N67-14888# Los Alamos Scientific Lab., N. Mex.
**DIRECT AND COMPOUND-NUCLEUS REACTIONS FOR $^{32}S(d,p)^{33}S$ AT LOW ENERGIES**
R. B. Leachman [1966] 9 p refs Presented at the Intern. Conf. on Nucl. Phys., Gatlinburg, Tenn.
(Contract W-7405-ENG-36)
(LA-DC-8082; CONF-660906-8) CFSTI: HC $1.00/MF $0.50

The contributions of direct-reaction and compound-nucleus mechanisms in the reaction $^{32}S(d,p)^{33}S$ were investigated. Excitation functions for the reaction were measured between 2.5 and 4.6 MeV at eight angles between 10 and 170°. The direct-reaction and compound-nucleus cross sections were obtained from the excitation functions by determining the fraction of direct reaction from fluctuation analyses. The experimental results were compared with the results of calculations. NSA

N67-14798*# General Electric Co., Philadelphia, Pa.
**STRUCTURAL MECHANICS OF DEFORMATION AND FRACTURE Quarterly Progress Report**
I. J. Gruntfest and G. E. Mueller Nov. 1966 34 p refs
(Contract NASw-1190)
(NASA-CR-80918) CFSTI: HC $2.00/MF $0.50 CSCL 20K

As part of a continuing exploration of the mechanical behavior of materials which have temperature dependent properties, the effect of a hammer blow on a small sample of model viscoelastic material is considered. In this situation, the duration of the experiment is long compared with the time required for stress equilibrium to develop and short in comparison with the thermal relaxation time of the sample. The analysis shows how a material which responds in an almost perfectly elastic manner to a light blow can respond in a viscous manner to a heavy blow. It also suggests that a homogeneous continuum with properties that would make it acceptable as a structural material must be brittle. This result may contribute to the understanding of the important relationship between microstructure and ductility. The hammer experiment involves relatively high strain rates which vary continuously during the deformation. Author

N67-14872# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE PENETRATION OF BARRIERS BY METEORITES**
E. I. Andriankin *In its* Cosmic Res. 4 Aug. 1966 p 165–185 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

A theoretical evaluation of the characteristic magnitudes in the penetration of barriers by meteorites is presented. Approximation formulas for the determination of the penetration diameters are presented, as well as the magnitudes of mass, momentum, energy and spreading angle of the plasma behind the barrier. Comparison of theory with experiments by a number of authors into the penetration of barriers under laboratory conditions of impact velocities shows identical qualitative theoretical and experimental relationships. Author

N67-14873# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE PENETRATION OF A THIN SHIELD BY A METEORITE**
A. K. Mukhamed Zhanov *In its* Cosmic Res. 4 Aug. 1966 p 186–194 refs (See N67-14861 05-30) CFSTI: HC $6.00/MF $1.50

The phenomenon of the penetration of a thin shield by a meteorite is considered for the case in which the thickness of the barrier is on the order of or less than the characteristic dimension of the data. With a number of assumptions with regard to the distribution of energy on the impact and the mechanism of the development of the penetration, an evaluation of the penetration diameter is presented as a function of the characteristic parameters of the phenomenon. Author

N67-14883*# North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.
**MECHANICAL IMPACT SYSTEM DESIGN FOR ADVANCED SPACECRAFT (MISDAS). PHASE I: DESIGN CONCEPT SELECTION**
A. I. Bernstein 20 Sep. 1965 99 p refs
(Contract NAS9-4915)
(NASA-CR-80968; SID-65-1205) CFSTI: HC $3.00/MF $2.60 CSCL 22B

The primary objective of this study is the design of a mechanical impact attenuation system for earth landing of advanced Apollo-type spacecraft. The system is to be adaptable to Apollo with minimum modification; and must absorb landing impact, protect crew and structure from excessive forces, prevent overturning of the spacecraft, and be reusable with minor refurbishment. The analyses have led to the recommendation of a six-segment heat shield design which satisfies the system performance criteria at minimum weight and minimum modification to the Apollo primary structure. Author

N67-14906*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**THE DESIGN AND TESTING OF AN INFLATED SPHERE IMPACT LIMITER**
R. G. Ross, Jr. and W. E. Layman 15 Dec. 1966 35 p
(Contract NAS7-100)
(NASA-CR-81030; JPL-TR-32-1037) CFSTI: HC $3.00/MF $0.65 CSCL 22B

An inflated-sphere landing vehicle is analyzed in terms of structural requirements and geometric configurations necessary to effect maximum utilization of the vehicle's energy-absorbing properties. The requirements for an optimum limiter are set forth and all important derivations are included. Fabrication techniques developed during the construction of a prototype vehicle are discussed and specific recommendations are made for future fabrication. Preliminary test results obtained by shooting a 5-ft diameter prototype impact limiter against a flat surface at velocities of 100 and 165 ft/sec are presented. Impact testing was conducted in a large vacuum chamber fitted with a launching mechanism designed for the prototype impact limiter. Author

N67-14916*# Astro Research Corp., Santa Barbara, Calif.
**METEOROID DAMAGE TO FILAMENTARY STRUCTURES**
Richard H. MacNeal [1966] 30 p refs
(Contract NAS7-427)
(NASA-CR-80956; ARC-R-222) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Fracture rates due to micrometeoroid impact are computed for solid round wires, flat tapes and thin-walled hollow tubes. The calculations are based on an extension of test data for the penetration of flat plates and on recent (1965) estimates of meteoroid flux. The results show that solid wires are much more vulnerable to meteoroid damage than either flat tapes or hollow tubes. Author

N67-14923*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**PROPOSED MANNED DYNAMIC TESTING OF SPACE STRUCTURES**
Larry Kiefling 5 Dec. 1966 20 p
(NASA-TM-X-53545) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Dynamics problems likely to be encountered in orbital structures and some possible investigations to study these problems are outlined. The items proposed are dynamic measurements at each step in space station development, inclusion of failure analysis capability with space rescue mission, and an orbiting structures laboratory. Role of manned participation is emphasized. A more detailed outline of one possible vibration test experiment is also included. The prime object of this experiment to evaluate test equipment and procedures in orbit. Author

N67-14928*# California Inst. of Tech., Pasadena.
**THE INFLUENCE OF PREBUCKLING DEFORMATION ON THE BUCKLING LOAD OF TRUNCATED CONICAL SHELLS UNDER AXIAL COMPRESSION**
Shigeo Kobayashi Washington, NASA, Jan. 1967 49 p refs
(Grant NsG-18-59)
(NASA-CR-707) CFSTI: HS $2.00/MF $0.65 CSCL 20K

An analytical investigation was carried out to determine the effect of prebuckling deformation on the compressive buckling load of truncated conical shells. The shell was assumed to have clamped boundary conditions and a finite difference approach was used to obtain the solution. In order to reduce the number of parameters and to clarify the essential property of the effect of the cone angle, a semi-infinite approach was used. It was concluded that the buckling load is determined by local buckling in the region close to the smaller radius end. The decrease in the buckling load from the classical result as a result of prebuckling deformation was somewhat greater for the conical shell than that for the cylindrical shell. However, the effect of the cone angle on this decrease is very small. Author

N67-14955# General Electric Co., Philadelphia, Pa. Missile and Space Div.
**APPLICATIONS AND OPTIMIZATIONS OF STRUCTURAL COMPOSITES FOR AIRCRAFT WINGS**
Norris F. Dow Oct. 1966 33 p refs Presented at the 23d Meeting of the Structures and Mater. Panel, Advisory Group for Aerospace Res. and Devel., NATO, Paris, 5 Oct. 1966
(R66SD55; AD-642092) CFSTI: HC $3.00/MF $0.65

By structural efficiency valuations the potential of advanced filamentary composites for improvements in aircraft wing construction is assessed. Various optimized structural approaches are considered, but it is shown that really only through the utilization of such enhanced stiffness/density and strength/density properties as the composites make accessible can substantial weight savings be achieved. Author (TAB)

N67-14960# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ABOUT A CERTAIN PROBLEM OF THE OSCILLATIONS OF AN ORTHOTROPIC PLATE PLACED IN A HIGH-TEMPERATURE FIELD**
S. A. Ambartsumyan 13 Jun. 1966 11 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk: Mekhan. i Mashinostr. (Moscow), no. 4, 1963 p 133–137
(FTD-TT-65-1931; TT-66-62233; AD-638883) CFSTI: HC $1.00/MF $0.50

Consideration is given to an orthotropic plate of uniform thickness referred to the Cartesian coordinates x, y, z, in such a way that the average plane of the nondeformed plate coincides with the coordinate plate xy. The material of the plate conforms to Hook's law and at each point has three planes of elastic symmetry parallel to the coordinate planes. Assumptions are that the temperature in the plate $T = T(x,y)$, and that in the first approximation only the modules of elasticity depend on the temperature. C.T.C.

N67-15002# General Electric Co., Philadelphia, Pa. Missile and Space Div.
**ON THERMOELASTICITY OF NONHOMOGENEOUS, ANISOTROPIC SHELLS**
E. Hoer Nov. 1966 40 p refs
(R66SD60; AD-642122) CFSTI: HC $3.00/MF $0.65

Starting with a three-dimensional continuum, general equations for arbitrary shells are derived allowing for arbitrary displacements within the shell body. Using a power series expansion for the displacements in terms of the thickness coordinate, the derivations are valid also for shells which are not necessarily thin and are based on the assumption of small deformations and on nonhomogeneous, anisotropic, elastic material. Thermal stresses due to arbitrary temperature distributions in space and time are included. Author (TAB)

N67-15007# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
**SOLUTIONS OF THE HOMOGENEOUS DIFFERENTIAL EQUATIONS OF THE AXIALLY COMPRESSED CIRCULAR CYLINDRICAL SHELLS**
K. A. V. Pandalai May 1966 37 p refs
(Contract AF 49(638)-1276)
(SUDAAR-273; AFOSR-66-1536; AD-642126) CFSTI: HC $3.00/MF $0.65

Donnel's equations are used to study the deformations of a thin-walled, circular cylindrical shell simply supported at its two circular edges and subjected simultaneously to an axial compressive load and a line load distributed sinusoidally along a generator. The problem of instability does not arise as the magnitude of the axial compressive load is below its critical value. Explicit expressions are derived for displacements, membrane stresses, moment resultants and transverse shear force resultants. The basic quantities useful in dealing with a practical problem or in considering a numerical example are tabulated and plotted. Author (TAB)

N67-15057# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CERTAIN PROBLEMS OF ELASTIC–PLASTIC OSCILLATIONS OF RODS**
A. I. Buravtsev 29 Apr. 1966 12 p refs Transl. into ENGLISH from Vestn. Leningr. Univ., Ser. Mat., Mekh. i Astron. (Leningrad), no. 1, 1965 p 77–83
(FTD-TT-65-1830; TT-66-62464; AD-640487) CFSTI: HC $1.00/MF $0.50

A problem of propagation of the elastic-plastic waves in shafts of finite length with different boundary conditions is discussed. The dependence of tension on deformation is expressed mathematically. The solution is given in the finite form. Author (TAB)

N67-15103# Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
**RANDOM VIBRATION OF MULTI DEGREE OF FREEDOM HYSTERETIC STRUCTURES**
Dean Karnopp and Richard N. Brown Sep. 1966 25 p refs
(Contract AF 49(638)-1314)
(AFOSR-66-2111; AD-642127) CFSTI: HC $3.00/MF $0.65

A method is developed for analyzing vibratory systems which may exhibit yielding or other hysteretic behavior under broad band random forcing. The techniques rely on a balance of power supplied by the forcing and dissipated in hysteretic effects. One and two degree of freedom examples are considered in detail and general concepts are given where possible. Limitations inherent in the method are discussed.
Author (TAB)

N67-15160# Advisory Group for Aerospace Research and Development, Paris (France).
**A SURVEY ON PANEL FLUTTER**
D. J. Johns Nov. 1965 139 p refs Presented at the 21st Meeting of the AGARD Struct. and Mater. Panel, Nancy, Nov. 1965 *Its* Avisory Rept.-1
CFSTI: HC $4.00/MF $1.00

This report presents a survey of panel flutter research in the NATO countries as determined by visits during 1965, including a discussion on panel flutter criteria, certain conclusions, and recommendations for future work. Discussed are the results of the visits to individual research establishments and workers. An extensive (288 references) bibliography on panel flutter is given. Selected additional references on static panel aeroelastic behaviour are included. Author

N67-15168# Joint Publications Research Service, Washington, D. C.
**SOVIET RESEARCH ON SCIENTIFIC BASES OF STRENGTH AND PLASTICITY OF MATERIALS IN 1965**
E. Ya. Filatov 22 Dec. 1966 15 p refs Transl. into ENGLISH from Prikl. Mekhan. (Kiev), v. 2, no. 9, 1966 p 130–137
(JPRS-39233; TT-66-35655) CFSTI: $1.00

Principal results of research on the strength and plasticity of materials are highlighted. Areas covered include static and quasistatic strength and bearing capacity, dynamic strength and bearing capacity, heat resistance, thermoelasticity and thermoplasticity, rheology and mechanics of systems made of polymeric materials, construction mechanics of thin walled structures, stress concentrations, the theory of oscillations and stability, and rock mechanics. C.T.C.

N67-15177# Joint Publications Research Service, Washington, D. C.
**CELLULAR STRUCTURES AS LOAD-BEARING STRUCTURAL ELEMENTS**
Gert Hintersdorf 10 Jan. 1967 17 p Transl. into ENGLISH from Muanyag (Budapest), v. 2, no. 10, 1965 p 289–294 Presented at the Conf. on Plastics in the Machine Ind., Budapest, 13 Nov. 1964
(JPRS-39468; TT-67-30118)

The strength and elastic properties of glass fiber reinforced plastics are compared with the properties of other structural materials and it is noted that glass fiber material properties are considerably less favorable. To eliminate this disadvantage a design is demonstrated which applies to the theory of sandwich structure. The importance of understanding material buckling stress is emphasized because this stress is usually smaller than the compression strength of laminated material, determined on cubical test specimens. A.G.O.

# 33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N67-14387# Lockheed Missiles and Space Co., Sunnyvale, Calif.
**ON THE MECHANISM OF HEAT AND MASS-EXCHANGE DURING VIBRATIONS OF A SUBLIMING BODY UNDER FREE CONVECTION CONDITIONS IN A RAREFIED GAS MEDIUM**
P. A. Novikov and B. M. Smol'skii [1965] 7 p Transl. into ENGLISH from Vopr. Nestats. Peresnosa Tepla i Massy, Nauka i Tekhnika (Minsk), 1965 p 105–111

The methods for conducting an investigation of the heat and mass exchange in the presence of vibrational motion are discussed, and results from an experimental study to clarify the influence of the body vibration rate on heat and mass transfer during sublimation under vacuum conditions are discussed. It is reported that utilization of body vibration as an intensifier of the sublimation process may not always result in a rise in the heat and mass exchange intensity. The degree of this influence depends on the ratio of the turbulent perturbations which are caused by the vibrating body, to the natural processes of vapor formation. When the evaporation is slight, the application of artificial oscillations

may yield an essential effect, and conversely, under intense evaporation vibration will not affect an increase in the intensity of heat and mass exchange. A.G.O.

N67-14388# Lockheed Missiles and Space Co., Sunnyvale, Calif.
**INFLUENCE OF THE BODY VIBRATION RATE ON THE HEAT AND MASS TRANSFER DURING SUBLIMATION UNDER VACUUM CONDITIONS**
P. A. Novikov [1965] 5 p refs Transl. into ENGLISH from Vopr. Nestats. Peresnosa Tepla i Mass. Nauka i Tekhnika (Minsk), 1965 p 99–104

The heat and mass exchange process was investigated during the vibration of a subliming body under vacuum conditions. Results show that the influence of body vibration on the intensity of both sublimation and convective heat exchange becomes significant only for vibrations with large oscillation amplitudes. A particularly perceptible effect is obtained when the oscillation amplitude exceeds the characteristic dimension of the subliming body. A.G.O.

N67-14487*# Esso Research and Engineering Co., Linden, N. J.
**VISCOUS HEATING AND CAPILLARY FLOW**
J. E. Gerrard and W. Philippoff *In* Brown Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 2 1965 p 77–94 refs (See N67-14581 05-34) CFSTI: HC $10.34/MF $3.00

Changes in measured viscosity introduced by viscous heating are quantitatively related to measurable temperatures of the system through a proposed model of flow. The walls of the cylindrical capillaries are held adiabatic, and the axial distributions of temperature at the wall are accurately determined. Excellent agreement is found between measured and calculated flow rates under all but very severe conditions. It is proposed that real non-Newtonian behavior can be separated from heating losses. Although the bulk temperature rise of the stream never exceeds 14°F, temperature gradients across the steam on capillaries can exceed 150°F. At shear stresses of $10^5$ to $10^6$ dynes/cm$^2$, apparent viscosity decreases of fivefold are observed resulting exclusively from viscous heating. The approach developed accounts for the observed apparent viscosity within 10%. Under the same conditions, the extent of apparent viscosity loss for four capillaries is shown to be a linear function. The bulk temperature rise is shown to bear no useful relation to apparent viscosity decreases caused by viscous heating. Author

N67-14713# Instituto Nacional de Tecnica Aeroespacial, Madrid (Spain).
**HYBRID COMBUSTION AND FLAME STRUCTURES Final Report, Apr. 1, 1965–Mar. 31, 1966**
Carlos Sanchez Tarifa 31 Mar. 1966 29 p refs
(Grant AF-EOAR-65-70)
(AFOSR-66-2102; AD-640501) CFSTI: HC $2.00/MF $0.50

The report summarizes the results obtained in a research effort accomplished on (1) hybrid combustion (flame propagation over the surface of a solid or liquid fuel in a gaseous oxidizer environment), and (2) flame structures (hydrogen-oxygen flame with a spherical symmetry and combustion of metals). A theoretical model is presented and discussed for the solution of flame propagation for the case of hybrid (solid-gas) systems based on the assumption that heating of the fuel ahead of the flame governs the flame propagation speed. Theoretical results are compared with those obtained from an experimental investigation of flame propagation along hollow cylinders of thermoplastic fuels through which a flow of oxygen circulates, and they are shown to agree reasonably well. A model is also discussed for the laminar spherical symmetrical hydrogen-oxygen diffusion flame, and analytical expressions relating the fundamental variables of the process are presented. Theoretical calculations are compared with the results obtained from an experimental investigation, and a qualitative agreement was obtained in the position of the flame front and the surface temperature. Author (TAB)

N67-14747# United Technology Center, Sunnyvale, Calif.
**SECOND AFOSR COMBINED CONTRACTORS MEETING ON COMBUSTION DYNAMICS RESEARCH**
Aug. 1966 82 p Meeting held 8–10 Aug. 1966 Compilation of Abstracts
(Contract AF 49(638)-1557)
(AFOSR-66-0581; AD-640468) CFSTI: HC $3.00/MF $0.75

The report consists of a collection of abstracts of the numerous research progress reports given by AFOSR contractors. These papers presented over a two-day period composed the 2nd Annual Meeting on Combustion Dynamics Research. Each paper was grouped under one of three major subject headings: Advanced Air Breathing Combustion, Liquid Propellant Rocket Combustion, or Solid Propellant Rocket Combustion. Author (TAB)

N67-14922*# Avco Corp., Tulsa, Okla. Electronics Div.
**EVALUATION OF THERMAL CONTROL COATINGS IN THE SPACE ENVIRONMENT Final Report, Feb. 1965–Aug. 1966**
James A. Cooley Dec. 1966 64 p refs
(Contract NASw-1162)
(NASA-CR-73028; TR-66-G103-F) CFSTI: HC $3.00/MF $1.30 CSCL 20M

Samples of $ZnO/K_2SiO_3$ thermal coating were tested under various conbinations of vacuum, temperature, solar electromagnetic, and proton environments to determine their effects on solar absorptance. Ultraviolet damage increased with increased temperature while proton damage decreased with increasing temperature. An apparent rate effect for 10 KeV protons at room temperature and below appeared to be reversed at elevated temperature. Damage from conbined ultraviolet–proton environment was less than the algebraic sum of damages due to the individual parameters. Change in solar absorptance of $SiO_x$ on vapor deposited aluminum was minimal in any of the environments. Author

N67-14937*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**THERMAL CHARACTERISTICS OF A STORAGE VESSEL ON THE MOON**
James K. Harrison Washington, NASA, Jan. 1967 54 p refs
(NASA-TN-D-3785) CFSTI: HC $2.50/MF $0.65 CSCL 20M

A theoretical analysis has been performed to study the thermal characteristics of a liquid hydrogen storage vessel on the moon. Investigations were conducted concerning the influences on temperature and propellant venting by such factors as insulation thermal conductivity, nondiffuse lunar radiation, the shadow cast by the vessel on the lunar surface, shape and size of the vessel, number of isothermal elements into which the vessel surface is divided, and the solar absorptance and infrared emittance ratio of the vessel surface. No calculations were made to estimate the heat transfer through structural penetrations. The factors found to have the most influence were: thermal conductivity of insulation, size and shape of vessel, solar absorptance and infrared emittance ratio, and shadow cast by the vessel on the lunar surface. Author

N67-15014# Northern Research and Engineering Corp., Cambridge, Mass.
**HEAT TRANSFER STUDIES OF WATER-SPRAY FLOWS**

J. E. Smith Wright-Patterson AFB, Ohio, ARL. May 1966 116 p refs
(Contract AF 33(615)-2340)
(ARL-66-0091; Rept.-1093-1; AD-642281) CFSTI: HC $3.00/MF $0.65

An experimental investigation into the heat-transfer characteristics of two-component, two-phase flows about a cylinder is described. Heat-transfer coefficients were measured at various positions around the periphery of the cylinder with systematic variations of cooling stream velocity, droplet size, and liquid-gas mass-ratio. The two-component cooling stream was a mixture of water droplets in air. An analysis of the heat-transfer characteristics over the front half of the cylinder, where the bulk of the heat transfer takes place, has been carried out for a simpled model. In this model, the air is assumed to be incompressible, and bouncing of droplets from the surface of the cylinder has been ignored. It has been found that this analysis gives some valuable insight into the relative importance of the various mechanisms which contribute to the over-all heat transfer. Both the experimental and the analytical results show that, in general, significant increases in heat transfer are obtained over that which would be obtained from a single-component gaseous cooling fluid. Author (TAB)

N67-15021# Brown Univ., Providence, R. I. Div. of Engineering.
**THE COMPUTATION OF CONTINUOUS TRANSFORMATION DIAGRAMS FROM ISOTHERMAL DATA**
L. M. Markowitz and M. H. Richman Aug. 1966 18 p refs
(Contract ARPA SD-86)
(E34; AD-640058) CFSTI: HC $1.00/MF $0.50

A basic program is presented to allow high speed digital computation of continuous transformation diagrams from data available in the form of isothermal transformation diagrams. The program follows the method of Grange and Kiefer (Transformation of Austenite on Continuous Cooling and Its Relation to Transformation at Constant Temperature,' Trans. ASM., 32, (1941), 85-116), and continuous transformation diagrams computed by this method are shown to agree favorably with experimental diagrams. Author (TAB)

N67-15055# Aeronutronic, Newport Beach, Calif. Applied Research Labs.
**THERMODYNAMIC PROPERTIES OF PROPELLANT COMBUSTION PRODUCTS Third Quarterly Letter Report, 1 Jan.-31 Mar. 1966**
31 Mar. 1966 9 p refs
(Contract AF 49(638)-1577; ARPA Order 317)
(QLR-66-4; AFOSR-66-1367; AD-640471) CFSTI: HC $1.00/MF $0.50

The objective of the program is to provide thermodynamic data for species which are potentially important combustion products of advanced chemical rockets and for related species. Enthalpy and entropy data are obtained from equilibrium measurements made by torsion-free evaporation and torsion-effusion techniques and by high temperature mass spectrometry. Vapor pressure data for lithium were obtained and, from these measurements the heat of vaporization of lithium was found to be 38.3 plus or minus .4 Kcal/mole. The beam modulation modification for the mass spectrometer was found to operate very well. TAB

N67-15056# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CHARACTERISTICS OF HIGH TEMPERATURE REACTION OF CARBON WITH GASES**
G. P. Khaustovich and Ye. S. Golovina 6 Apr. 1966 12 p refs Transl. into ENGLISH from Inzh.-Fiz. Zh. (Minsk), v. 7, no. 3, 1964 p 92-96
(FTD-TT-66-1671; TT-66-62440; AD-640302) CFSTI: HC $1.00/MF $0.50

Presented are results of experimental investigation of reaction of spherical carbon particles with carbon dioxide and oxygen at temperatures of 2500-3200K. Author (TAB)

N67-15151*# General Electric Co., Cincinnati, Ohio.
**HEAT TRANSFER AND PRESSURE DROP MEASUREMENTS FOR HIGH TEMPERATURE BOILING POTASSIUM IN FORCED CONVECTION**
J. A. Bond, J. R. Peterson, and F. E. Tippets [1965] 45 p refs
(Contract NAS3-2528)
(NASA-CR-81080) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Boiling potassium heat transfer data were obtained over a range of mass velocities, heat fluxes, and qualities at temperatures up to 2100°F in single-tube test sections. Experiments were conducted in a two-fluid 300 kW facility in the transition boiling and superheated vapor regimes at temperatures up to 1750°F, and in a radiant-heated 100 kW facility for the test measurement up to 2100° F. Described are the experimental equipment and measurement techniques. The resulting measurements of critical heat flux conditions and wall temperature behavior are useful for application to design and give information on the nature of the forced convection boiling process for potassium at high temperature and high vapor qualities. K.W.

N67-15219*# Warner and Swasey Co., Flushing, N. Y. Control Instrument Div.
**USE OF INFRARED BAND MODELS TO DETERMINE $H_2O$ AND $CO_2$ CONCENTRATIONS IN SITU AT HIGH TEMPERATURES Final Report**
Gunter J. Penzias 12 Feb. 1966 40 p refs
(Contract NAS3-6282)
(NASA-CR-54914; TR-40) CFSTI: HC $3.00/MF $0.65 CSCL 21B

The statistical band model was used to establish quantitative relationships for use in combustion gas analysis for propulsion research applications. The necessary band model parameters, to relate infrared transmittance to $CO_2$ and $H_2O$ concentrations were determined from 600°K to 2500°K at 4.40-$\mu$ for $CO_2$ and at 2.506-$\mu$ and 2.854-$\mu$ for $H_2O$. Improvements in the technique for determining $H_2O$ concentrations, using integrated absorptance methods, and possible modification of the statistical model relationships, were investigated. The effects of nonabsorbing broadening gases on concentration determinations were also considered. Author

N67-15222# AeroChem Research Labs., Inc., Princeton, N. J.
**IONIZATION IN HYDROCARBON FLAMES**
H. F. Calcote *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. I 1965 p 1-42 refs (See N67-15221 05-25)
CFSTI: HC $7.00/MF $1.75
(Contract Nonr-3809(00))

Experimental observations on ionization in hydrocarbon flames are summarized in the form of a series of factual statements, and the twelve most probable ionic flame reactions are derived from these statements. In general, the reaction mechanisms involving ionic species are sufficiently well understood that the flame can now be considered as a medium for measuring reaction rates involving ions. Mechanisms for producing $C_3H_3^+$ and $CH_3O^+$ mechanism for the formation of negative ions, and the actual negative ion concentration in hydrocarbon flames are discussed. Author

N67-15223# Shell Research, Ltd., Chester (England). Thornton Research Centre.
**PROCESSES OF IONIZATION AND RECOMBINATION OF METALLIC ADDITIVES IN FLAMES**

T. M. Sugden *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. I 1965 p 43–64 refs (See N67-15221 05-25) CFSTI: HC$7.00/MF$1.75

An important source of flame ionization is the alkali metals and alkaline earth elements which have markedly lower ionization potentials than other constituents of flame gases. Various hypotheses of mechanisms by which the alkali ions are formed are discussed, including the thermal ionization characteristics of the flame. The addition of a halogen may increase the electron concentration in a flame; it is concluded that a mechanism in which the halogen acts as a homogeneous catalyst is operative. Author

**N67-15224#** Rocket Propulsion Establishment, Westcott (England).

**POSITIVE ION COLLECTION BY SPHERICAL PROBES IN HIGH PRESSURE FLAME PLASMAS**

I. W. Salter and B. E. L. Travers *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. I 1965 p 65–79 refs (See N67-15221 05-25) CFSTI: HC $7.00/MF $1.75

The continuum theory for positive ion collection on a spherical probe operating at high pressure has been investigated in seeded hydrogen–oxygen–nitrogen flames at atmospheric pressure. The results obtained, some of which are at variance with the theory, were applied to subatmospheric pressure acetylene–air flames to estimate ion densities in these flames. Ion densities obtained by direct application of the theory resulted in values several orders of magnitude too high. Author

**N67-15225#** Cornell Univ., Ithaca, N. Y. Graduate School of Aerospace Engineering.

**SURFACE EFFECTS IN SEEDED COMBUSTION PRODUCTS**

Donald L. Turcotte *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. I 1965 p 81–122 refs (See N67-15221 05-25) CFSTI: HC$7.00/MF$1.75

(Contract AF 49(638)-1346)

Current–voltage characteristics of a double probe were obtained in the products of combustion of a seeded, atmospheric pressure, alcohol–air flame. Sodium hydroxide, potassium hydroxide, and cesium chloride were the seed compounds. Saturation currents were measured which were independent of the electrode temperature below 500°K and increased rapidly when the electrode temperature was increased above 500°K. The appropriate continuum sheath theory is developed. The properties of the combustion products are calculated, and partial dissociation of the seed molecules and electron attachment to the hydroxyl radical are considered. The calculated resistances are in agreement with the measured values. The calculated ion saturation currents are three to four orders of magnitude smaller than the measured values. It is concluded that there is electron emission from the electrodes. The dependence of the saturation currents on the electrode temperature is explained by thermal emission of electrons from the electrodes. Data on the work function of a metal surface in the presence of an alkali vapor are in good agreement with this value. Author

**N67-15226#** Oxford Univ. (England). Clarendon Lab.

**CONTRIBUTIONS OF ELECTRONS TO IONIZATION IN FLAME GASES**

A. van Engle and J. R. Cozens *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. I 1965 p123–138 refs (See N67-15221 05-25) CFSTI: HC $7.00/MF $1.75

The origin of electrons and ions, the excessive ionization and the large electron mean energy in active flames are discussed. Chemi-ionization, besides thermal ionization, has been put forward to account for the presence of free charges, produced by collisions between two species in the ground state which react with one another. Recently it has been proposed that electron collisions with molecules are largely responsible for ionization. Electrons produced thermally in the hot flame gas can pick up energy from species in states of higher potential energy and thus acquire mean energies considerably above those of the gas molecules. Such collisions of the second kind quench the excited states which are always present as a result of combustion reactions. Chemi-ionization can only produce electrons of low energy, unless excited species are assumed to interact, in which case collisions of the second kind would again be instrumental. Experimental evidence seems to support the electron collision picture. Author

**N67-15227#** Massachusetts Inst. of Tech., Cambridge.

**CHEMI-IONIZATION IN GASEOUS DETONATIONS**

Jon R. Kelly, Tau-Yi Toong, and Chee-Chen Tung *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. I 1965 p 139–159 refs (See N67-15221 05-25) CFSTI: HC $9.00/MF $1.75

(Grants DA-ARO(D)-31-124-G190; DA-ARO(D)-31-124-G593; NSF G-20880)

A constant voltage, dc probe is used to investigate profiles of electrical conductivity in acetylene–oxygen and propane–oxygen detonations at sub-atmospheric initial pressures. A clear distinction is found between regions of dominant chemi-ionization and dominant thermal ionization. At low initial pressures the probe-current profiles exhibit a peak in the reaction zone, followed by a decay to a current level which is compatible with the calculated equilibrium ionization (as much as 20 times lower than the peak value). The role played by chemically-produced electrons in the early development of thermal ionization, and the rates of decay of electron concentration behind the reaction zone are discussed. Author

**N67-15228#** Rocket Propulsion Establishment, Westcott (England).

**A SIMPLE ELECTROSTATIC PROBE FOR THE MEASUREMENT OF ION DENSITIES IN ATMOSPHERIC PRESSURE FLAMES AND ITS APPLICATION TO A STUDY OF CHARGE EXCHANGE REACTIONS IN HYDROCARBON FLAME GASES**

R. G. Soundy and H. Williams *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. I 1965 p 161–189 refs (See N67-15221 05-25) CFSTI: HC $7.00/MF $1.75

There is a need in the kinetic chemistry of ionization in flame gases at near atmospheric pressure for a method of measuring accurately the local ion density with a high degree of spatial resolution. A description is given of a simple probing technique. Some interesting results obtained during the application of the technique to a study of charge exchange reactions between natural flame ions and added metallic elements are also presented. Author

**N67-15229#** Shell Research, Ltd., Chester (England). Thornton Research Centre.

**OBSERVATIONS ON NEGATIVE IONS IN HYDROCARBON FLAMES**

J. A. Green *In* AGARD Fundamental Studies of Ions and Plasmas, Vol. I 1965 p 191–214 refs (See N67-15221 05-25) CFSTI: HC $7.00/MF $1.75

Some spectrometer observations made on flames at atmospheric pressure are reported that extend the scope of earlier work on negative ions with respect to actual species and their dependence on position in the flame and on the amount of hydrocarbon present. These studies suggest that the following results are correct: (1) The number of negative ions in the

reaction zone is always considerably smaller than that of electrons. (2) The $O_2^-$ ion is formed in largely unburnt gas by direct attachment of electrons deriving from the reaction zone by ambipolar diffusion. (3) The $OH^-$ and $C_nH_m^-$ ions are formed in the reaction zone with no clear distinction as yet between direct and dissociative attachment of electrons. (4) The $C_nH^-$ ions are formed in amounts consistent with their stabilities. (5) The $CHO_2^-$ ion is not a genuine flame but rather an artifact arising from the presence of the sampling system. Author

**N67-15256*#** National Bureau of Standards, Boulder, Colo.
**SATELLITE REFRIGERATION STUDY. PART I: Technical Analysis**
P. C. Vander Arend, D. B. Chelton, and D. B. Mann 1 Sep. 1964 50 p refs Prepared for NASA
(NBS Proj. 31505-40-3150553)
(NASA-CR-81134; NBS-8444) CFSTI: HC $3.00/MF $0.65 CSCL 13A

This report is a review and analysis of the state-of-the-art of miniature refrigeration. The study was performed in an effort to determine present availability of a low temperature refrigeration system for satellite mounted infrared sensor cooling. To provide background for the analysis, a brief review of possible thermodynamic systems is made. The analysis deals with both open and closed cycles and components. It outlines fundamental problems, some of which are a function of the size of the component. On the basis of this analysis, predictions may be made as to the possible application of the various systems. A separate section deals with the subliming refrigerator, which basically consists of a storage dewar filled with a solid cryogen. A review of the state-of-the-art indicates that up to the present, little work has been done by industry. Fundamentally, the subliming refrigerator appears very attractive for use in a satellite because of the zero power requirements and the high reliability which may be expected. The state-of-the-art in cryogenic engineering is sufficiently advanced to permit the construction of a reliable subliming refrigerator with the expenditure of moderate amounts of money and time. This is not true for some of the mechanical refrigerators now under development. Author

**N67-15289#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**PRESSURE DISTRIBUTION IN A VORTEX COMBUSTION CHAMBER**
P. M. Mikhaylov and A. N. Shtym 8 Apr. 1966 11 p refs Transl. into ENGLISH from Tr. Leningr. Politekhn. Inst. (Moscow), no. 232, 1964 p 42–46
(FTD-TT-65-1712; TT-66-62460; AD-640476) CFSTI: HC $1.00/MF $0.50

Based on a model in which the flow in a cyclone is considered as a twisted cylindrical flow, an equation is derived which connects the dimensionless value of the drop in the static pressure $\Delta P$ with the dimensionless radius $\eta$. The distribution $\Delta P$ observed in experiments is analyzed, and it is shown that an approximation better satisfying the experimental data is the value $\Delta P$ determined on the basis of approximating the tangential velocity with $\eta$ as the constant of the magnitude. M.G.J.

**N67-15303#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE THEORY OF THE HEAT POTENTIAL. INSTALLMENT I: DIRECT VALUES OF THE HEAT POTENTIALS AND THE REVERSE PROBLEM IN THE THEORY OF THE HEAT POTENTIAL**
Wang T'ung 8 Apr. 1966 21 p refs Transl. into ENGLISH from Zh. Vychislitel'noi Mat. i Mat. Fiz. (Moscow), v. 4, no. 4, 1964 p 660–670
(FTD-TT-65-1686; TT-66-62463; AD-640474) CFSTI: HC $1.00/MF $0.50

A mathematical discussion is presented on the theory of heat potential, and two definitions are advanced. Results relating to the reverse problem in the theory of heat potential, and proof of theorems on direct values of heat potential are given. R.U.

**N67-15304#** Library of Congress, Washington, D. C. Aerospace Technology Div.
**THE THEORY OF DETONATION, THE COMBUSTION MECHANISM, AND THE PROPERTIES OF EXPLOSIVES Surveys of Foreign Scientific and Technical Literature**
Seraphim Parandjuk 21 Sep. 1966 36 p Compilation of Abstracts
(ATD-66-44; TT-66-62370; AD-639735) CFSTI: HC $2.00/MF $0.50

A compilation of abstracts is based on Soviet open sources published in 1965, together with one Satellite source published in 1965 and one Soviet source published in 1966. This is the fourth report in this series dealing with the theory of combustion the combustion mechanism, and the properties of explosives. There are 36 abstracts and no bibliography. Other information included: combustion zone, flame combustion, propellant oxidizer, thermal explosion, investigation of phase transitions sodium and potassium nitrates by means of Raman scattering spectra, blasting energy, gaseous and liquid explosives, nonsteady-state powder combustion, ignition of homogenous explosive particles in hot gas, ballistite burning, metastable substance, detonation process, metal fuel. Author (TAB)

# 34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

**N67-14462*#** Stanford Univ., Calif.
**PROCEEDINGS OF THE FOURTH INTERNATIONAL CONGRESS ON RHEOLOGY, PART 1**
Alfred L. Copley (N. Y. Med. Coll.) and E. H. Lee, ed. New York, Interscience, 1965 388 p refs Congr. held at Brown Univ., Providence, 26–30 Aug. 1963
(Grant NsG-509)
(NASA-CR-80885) CFSTI: HC $7.00/MF $1.75 CSCL 20D

CONTENTS:

1. RHEOLOGY OF INORGANIC GLASSES R. W. Douglas (Sheffield Univ.) p 3–27 refs (See N67-14463 05-18)

2. THE DEFORMATION PROCESS AND STRUCTURE OF CRYSTALLINE POLYMERS M. Horio (Kyoto Univ.) p 29–55 refs (See N67-14464 05-18)

3. SOME FLOW PROPERTIES OF BLOOD R. L. Whemore (Nottingham Univ.) p 57–71 refs (See N67-14465 05-12)

4. MECHANOCHEMISTRY A. Kaschalsky and A. Oplatka (Weizmann Inst. of Sci.) p 73–97 refs (See N67-14466 05-04)

5. PLASTIC DEFORMATION AND IMPERFECTIONS IN CRYSTALS (SUMMARY OF LECTURE) A. Seeger (Max-Planck-Institut für Metallforschung) p 99–102 refs (See N67-14467 05-26)

6. RHEOLOGY OF CYTOPLASMIC STREAMING N. Kamiya (Osaka Univ.) p 105–121 refs (See N67-14468 05-04)

7. NON-NEWTONIAN INTRINSIC VISCOSITY OF POLYMER SOLUTIONS A. Peterlin (Research Triangle Inst.) p 123–141 refs (See N67-14469 05-18)

8. SOME FUNDAMENTAL ASPECTS OF POLYMER EXTRUSION H. Janeschitz-Kriegl (Central Lab. TNO, Delft) p 143–160 refs (See N67-14470 05-34)

9. VISCOELASTIC BEHAVIOR OF CRYSTALLINE POLYMERS M. Takayanagi (Kyushu Univ.) p 161–212 refs (See N67-14471 05-18)

10. NORMAL STRESS MEASUREMENTS ON POLYMER SOLUTIONS H. Markovitz (Mellon Inst.) p 189–212 refs (See N67-14472 05-12)

11. SOME NON-NEWTONIAN EFFECTS IN FLOW THROUGH TUBES A. C. Pipkin (Brown Univ.) p 212–222 refs (See N67-14473 05-12)

12. MECHANICAL AND GEOMETRIC ANISOTROPY OF COHESIONLESS MEDIA J. Biarez (Grenoble Univ.) p 223–248 refs (See N67-14474 05-23)

13. SOME SECONDARY FLOW PHENOMENA IN GENERAL VISCOELASTIC FLUIDS H. Giesekus (Farbenfabriken Bayer, A. G.) p 249–266 refs (See N67-14475 05-12)

14. SECOND-ORDER STRESSES IN THE FLOW OF GASES M. Reiner (Israel Inst. of Tech.) p 267–279 refs (See N67-14476 05-12)

15. STRESS RELAXATION IN HIGH POLYMERS AND METALS J. Kubat (Swedish Forest Products Res. Lab.) p 281–297 refs (See N67-14477 05-32)

16. MATERIAL RELAXATION AND STRUCTURAL DAMPING J. Meixner (Rheinisch-Westfalische Technische Hochschule) p 299–316 refs (See N67-14478 05-32)

17. VISCOELASTIC RELAXATION IN LIQUIDS AND POLYMERS J. Lamb (Glasgow Univ.) p 317–344 refs (See N67-14479 05-12)

18. STABILITY OF FLOW OF A NON-NEWTONIAN LIQUID BETWEEN TWO ROTATING CYLINDERS IN THE PRESENCE OF A CIRCULAR MAGNETIC FIELD M. N. L. Narasimhan (Indian Inst. of Tech.) p 345–369 refs (See N67-14480 05-25)

19. SOME ORIENTED MATERIALS J. L. Ericksen p 370

20. DETERMINATION OF NON-NEWTONIAN FLOW AND NONLINEAR ELASTIC RECOVERY FROM LINEAR VISCOELASTIC BEHAVIOR Herbert Leaderman p 371–373 refs

**N67-14470*#** Central Lab. TNO, Delft (Netherlands).
**SOME FUNDAMENTAL ASPECTS OF POLYMER EXTRUSION**
H. Janeschitz-Kriegl *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 1 1965 p 143–160 refs (See N67-14462 05-34) CFSTI: HC $7.00/MF $1.75

Considered are some fundamental aspects of polymer extrusion, such as capillary flow of polymer melts, screw performance under nearly isothermal conditions, and heat transfer in the screw channel. The development of the slit viscometer is reported. Calibration of the output of the metering section of a screw extruder was carried out under nearly isothermal conditions with capillaries of various diameters in the die head. Heat transfer measurements were carried out with a measuring unit fitting in the axial bore of the metering section of the screw or in a hollow cylinder mounted at the tip of a shorter screw. Heat transfer measurements with the aid of a temperature probe for flowing polymer melts are reported. In addition, the increase of temperature in the measuring unit mentioned is determined as a function of viscous heating in the gap or in the screw channel. R.U.

**N67-14482*#** Brown Univ., Providence, R. I.
**PROCEEDINGS OF THE FOURTH INTERNATIONAL CONGRESS ON RHEOLOGY, PART 2**
E. H. Lee, ed. (Stanford Univ.) New York, Intersci. Publishers, Inc., 1965 735 p refs Proc. of the 4th Intern. Congr. held at Providence, 29–30 Aug. 1963
(Grant NsG-509)
(NASA-CR-80888) CFSTI: HC $10.24/MF $3.00 CSCL 20K

Conference papers are presented in the general areas of continuum mechanics, testing techniques, stress and strain distribution analysis, birefringence, metals, technology, polymers, polymer fluids, glasses, and dispersions. For individual abstracts, See N67-14582–N67-14519.

**N67-14521*#** Stanford Univ., Calif.
**PROCEEDINGS OF THE FOURTH INTERNATIONAL CONGRESS ON RHEOLOGY, PART 3**
E. H. Lee, ed. New York, Interscience, 1965 638 p refs Congr. held at Brown Univ., Providence, 26–30 Aug. 1963
(Grant NsG-509)
(NASA-CR-80887) CFSTI: HC $6.87/MF $2.50 CSCL 20K

Papers on continuum theory, stress and strain distribution analysis, technology, polymers, polymer fluids and solids, and dispersions are presented. For individual titles see N67-14522–N67-14555.

**N67-14530*#** General Motors Corp., Santa Barbara, Calif. Defense Research Labs.
**STATIC AND DYNAMIC PENETRATION TESTS OF SOIL**
R. Emori and D. Schuring *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 143–154 refs (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

Soil penetration tests performed with plates under gradually increasing static loads have been used for some time to predict the mobility of off-road vehicles. To fill a new need for penetration studies under dynamic, repetitive loading of the plate, an impacting soil measuring device has been developed. The force–penetration curves obtained by dynamic static methods show good agreement for both frictional and cohesive soils, and serve to predict the resistance that will be encountered by a moving vehicle. Author

**N67-14531*#** British Plaster Board (Holdings), Ltd., East Leake (England).
**STRESSES AND FLOW UNDER A TROWEL**
K. Schiller *In* Stanford Univ. Proc. of the 4th Intern. Congr. on Rheol., Pt. 3 1965 p 155–162 (See N67-14521 05-34) CFSTI: HC $6.87/MF $2.50

The traditional method for plastering the walls of a house is troweling. The rheology of the plaster slurry, a very dense suspension, is highly complex, especially as the composition may alter locally under the influence of arising stresses. The discussion opens with the most general assumptions admitting only dimensional analysis and purely kinematic relations, but regarding the material, though only to begin with, as highly viscous in the Newtonian sense, and incompressible. It is shown that the velocity field in the slurry (regarded as two dimensional) is independent of the value of the viscosity, and the result is generalized to show that it holds whenever the equation of state of the material contains only a single material constant. The behavior of a Bingham body, which has two material constants, is then explained. Experiments with real plaster slurries are then briefly discussed and it is pointed out that, although showing some similarities, a plaster slurry is, in fact, not a Bingham body. The paper concludes with a description of the troweling action on the basis of the preceding theoretical and experimental discussion. Author

**N67-14612#** Iowa State Univ. of Science and Technology, Ames. Ames Lab.
**CHEMISTRY, ENGINEERING, METALLURGY, PHYSICS AND REACTOR DIVISIONS Annual Summary Research Report, Jul. 1, 1965–Jun. 30, 1966**
F. H. Spedding Jul. 1966 497 p refs
(Contract W-7405-ENG-82)
(IS-1500) CFSTI: HC $7.94/MF $2.25

CONTENTS:

1. RESEARCH REPORT IN CHEMISTRY F. H. Spedding, R. S. Hansen, C. V. Banks, T. A. Beineke, J. D. Corbett et al 111 p refs (See N67-14613 05-06)

2. RESEARCH REPORT IN ENGINEERING F. H. Spedding, G. Burnet, L. E. Burkhart, R. W. Fisher, F. O. Shuck et al 34 p refs (See N67-14614 05-06)

3. RESEARCH REPORT IN METALLURGY F. H. Spedding, H. A. Wilhelm, O. N. Carlson, C. W. Chen, P. Chiotti et al 95 p ref (See N67-14615 05-17)

4. RESEARCH REPORT IN PHYSICS F. H. Spedding, D. J. Zaffarano, R. G. Barnes, B. C. Carlson, B. C. Cook et al 79 p refs (See N67-14616 05-24)

5. REACTOR UTILIZATION F. H. Spedding, W. H. McCorkle, J. S. Crudele, G. M. Day, B. W. Link et al 38 p refs (See N67-14617 05-22)

6. RESEARCH REPORT IN MATHEMATICS AND COMPUTER RESEARCH F. H. Spedding, B. C. Carlson, D. R. Fitzwater, and R. M. Stewart 9 p refs (See N67-14618 05-19)

**N67-14621*#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.

**RESEARCH LABORATORY OF ELECTRONICS Quarterly Progress Report, Period Ending 31 Aug. 1966**

15 Oct. 1966 217 p refs

(Contract NSR-22-009-120; Grants NsG-496; NsG-419; NsG-22-009-163; NGR-22-009-091 et al

(NASA-CR-80895; QPR-83) CFSTI: HC $6.00/MF $1.25 CSCL 09C

CONTENTS:

1. MICROWAVE SPECTROSCOPY J. M. Andrews, Jr. p 1–6 ref (See N67-14622 05-26)

2. RADIO ASTRONOMY D. H. Staelin, R. W. Neal, S. E. Law, E. C. Reifenstein, B. F. Burke et al p 7–14 refs (See N67-14623 05-30)

3. SOLID-STATE MICROWAVE ELECTRONICS R. P. Rafuse and D. H. Steinbrecker p 15–16 refs (See N67-14624 05-09)

4. OPTICAL AND INFRARED SPECTROSCOPY C. H. Perry, E. F. Young, and T. F. McNelly p 17–29 refs (See N67-14625 05-26)

5. PHYSICAL ELECTRONICS AND SURFACE PHYSICS D. S. Shupe and R. E. Stickney p 31–34 refs (See N67-14626 05-06)

6. PHYSICAL ACOUSTICS J. L. Macon p 35–36 refs (See N67-14627 05-25)

7. PLASMA PHYSICS J. C. Ingraham, G. Lampis, and R. L. Kronquist p 37–58 refs (See N67-14628 05-25)

8. GASEOUS ELECTRONICS B. L. Wright p 59–64 refs (See N67-14629 05-25)

9. PLASMAS AND CONTROLLED NUCLEAR FUSION A. Bers, R. R. Bartsch, S. R. J. Brueck, C. E. Wagner, and L. M. Lidsky p 65–77 refs (See N67-14630 05-25)

10. ENERGY CONVERSION RESEARCH J. L. Kerrebrock, M. A. Hoffman, G. C. Oates, and R. Decher p 79–93 refs (See N67-14631 05-25)

11. STATISTICAL COMMUNICATION THEORY A. G. Bose, A. V. Oppenheim, D. E. Nelsen, J. D. Bruce, and R. F. Bauer p 95–104 refs (See N67-14632 05-07)

12. LINGUISTICS M. Halle, V. J. Zeps, and J. P. Kimball p 105–128 refs (See N67-14633 05-34)

13. COGNITIVE INFORMATION PROCESSING O. J. Tretiak, H. P. Hartmann, J. A. Newell, S. D. Shoap, J. A. Williams et al p 129–158 refs (See N67-14634 05-08)

14. COMMUNICATIONS BIOPHYSICS M. B. Sachs p 159–164 refs (See N67-14635 05-04)

15. NEUROPHYSIOLOGY S. J. Wiesner (Brandeis Univ.), R. Moreno-Diaz, W. F. Pickard, and B. Howland p 165–178 refs (See N67-14636 05-04)

16. COMPUTATION RESEARCH M. M. Pennell and H. Davis p 179–181 (See N67-14637 05-19)

**N67-14633*#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.

**LINGUISTICS**

M. Halle, V. J. Zeps, and J. KP. Kimball *In its* Res. Lab. of Electron. 15 Oct. 1966 p 105–128 refs (See N67-14621 05-34) CFSTI: HC $6.00/MF $1.25

(Contracts AF 19(628)-2487; DA-36-039-AMC-03200(E); Grants NSF GK-835; NIH G-MH-04737-06)

This presentation contains the following studies: (1) a survey of seven rules or rule complexes governing alternations encountered in Latvian phonology; (2) an article concerning certain linguistic facts and rules regarding the metrics of pre-Islamic Arabic poetry; and (3) a definitive discussion of the implications consequent upon a positive solution to the intersection problem of regular languages and languages generated by transformational grammar. K.W.

**N67-14721** Lehigh Univ., Bethlehem, Pa. Center for Information Sciences.

**A FORMAL THEORY OF CONCEPTUAL AFFILIATION FOR DOCUMENT RECONSTRUCTION. REPORT NO. 1: THE AFFILIATION-VALUE MODEL**

Robert C. Heiser and Donald J. Hillman 22 Aug. 1966 32 p refs

(Grant AF-AFOSR-1028-66)

(AD-640083) CFSTI: HC $2.00/MF $0.50

It is first argued that there are significant logical and epistemological issues involved in the development of an adequate text-processing procedure for document retrieval systems. A brief discussion of these issues follows. It is next shown that the problem of characterizing or indexing a document is a particular form of the general logical problem of abstraction. The report introduces the notion of concretion into retrieval theory, and discusses the problem of reconstructing documents from their given characteristics. A major goal is to show that different coherence patterns for characteristics indicate differences among documents as to form, style, structure and content. An affiliation-value model is constructed, in terms of which the conceptual closeness and importance of characteristics to their parent documents are numerically expressible. Document structure, organization and content are reflected in the calculation of affiliation-values, so that it becomes possible to identify the form and nature of documents given only certain minimal information regarding their characteristics or index terms. Author (TAB)

**N67-14763*#** National Aeronautics and Space Administration, Washington, D. C.

**THE ROLE AND RESPONSIBILITY OF NASA IN RELATION TO SPACECRAFT STERILIZATION**

Homer E. Newell *In its* Spacecraft Sterilization Technol. 1966 p 11–18 refs (See N67-14761 05-05) GPO: HC $2.25; CFSTI: MF $2.50

The organizational structure of NASA and the functions of its program offices are briefly outlined, and the role of the Space Science Steering Committee and its advisory subcommittees is discussed. The importance of the search for extraterrestrial life is stressed, and the recommended constraints to prevent contamination are listed. These goals require that the probability of a single viable organism being aboard a spacecraft intended for Mars landing, or penetration of the Martian atmosphere, be less than $1 \times 10^{-4}$; the probability of accidental impact or atmospheric entry by an unsterilized flyby is to be kept to $3 \times 10^{-4}$ or less.

The problems involved in developing sterilization technology for planetary exploration are assessed, and the guidelines for meeting the established goals are listed. M.G.J.

**N67-14764*#** National Aeronautics and Space Administration, Washington, D. C.
**NASA PROGRAM SCOPE AND DEFINITION**
Orr E. Reynolds and Oran W. Nicks *In its* Spacecraft Sterilization Technol. 1966 p 19-24 ref (See N67-14761 05-05) GPO: HC$2.25; CFSTI: MF$2.50

Summary data are presented on NASA's Planetary Quarantine Program, and the organization of the offices responsible for this program is shown. These include the Lunar and Planetary Programs Office, whose work is directed to the evaluation or development of sterilizable flight hardware; and the Bioscience Programs Office, which is charged with defending the scientific basis for sterilization; developing sterilization techniques and defining the reliability of these techniques; conducting bioassays; monitoring all phases of manufacture, assembly and launch; approving procedures; and certifying sterility. The monitoring program is outlined, and the need for trained personnel is discussed in relation to the fellowship program and on-the-job training aids. M.G.J.

**N67-14804** Instituto de Pesquisas Technologicas, Sao Paulo (Brazil).
**THE TECHNOLOGICAL RESEARCH INSTITUTE OF SAO PAULO AND ITS CONTRIBUTIONS TO THE DEVELOPMENT OF METALLURGY IN BRAZIL [O INSTITUTO DE PESQUISAS TECHNOLOGICAS DE SAO PAULO E A SUA CONTRIBUICAO PARA O DESENVOLVIMENTO DA METALURGIA NO BRAZIL]**
Luiz C. Correa Da Silva *In* Arg. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 51 p ref In PORTUGUESE; ENGLISH summary (See N67-14801 05-17) CFSTI: HC$7.30/MF$2.00

This paper describes, and justifies, the methods of action, the resources employed and the past activities of the IPT of Sao Paulo, Brazil, and specially its Division of Metallurgy, as an institution supported by the state of Sao Paulo to promote and assist technically the Brazilian industry. It analyzes the kind of help that the IPT lends and will lend to the different groups of industries through testing, analyses, special studies, research, technical assistance, pilot plant production, dissemination of information, and teaching. The role of institutes of this kind in developing countries is also discussed. Author

**N67-14805** Argentina. Comision Nacional de Energia Atomica, Buenos Aires.
**PLAN OF ACTIVITIES OF THE DEPARTMENT OF METALLURGY OF THE CNEA [PLAN DE ACTIVIDADES DEL DEPARTAMENTO DE METALURGIA DE LA COMISION NACIONAL DE ENERGIA ATOMICA, ARGENTINA]**
Jorge A. Sabato *In its* 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 9 p In SPANISH; ENGLISH summary (See N67-14801 05-17) CFSTI: HC$7.30/MF$2.00

The laboratories of the Department of Metallurgy have three main functions to fulfill: to assist the (National Atomic Energy Commission) in all metallurgical problems related to the atomic projects of Argentina; to do pure and applied research in nuclear metallurgy with some efforts devoted to general physical, chemical, mechanical and process metallurgy; and to assist the Argentine metallurgical industry, in the solution of their problems. This is accomplished by means of well equipped laboratories, pilot plants and libraries, by offering courses at all levels (technicians to post-doctoral) and through the Service of Technical Assistance to the Metallurgical Industry. Author

**N67-14806** Argentina. Comision Nacional de Energia Atomica, Buenos Aires. Departamento de Metalurgia.
**PLAN OF ACTIVITIES OF THE SERVICE OF TECHNICAL ASSISTANCE TO INDUSTRY (SATI) [PLAN DE ACTIVIDADES DEL SERVICIO DE ASISTENCIA TECNICA A LA INDUSTRIA METALURGICA (SATI)]**
Oscar Wortman *In its* 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 7 p In SPANISH; ENGLISH summary (See N67-14801 05-17) CFSTI: HC$7.30/MF$2.00

The Service of Technical Assistance to the Metallurgical Industry was created by agreement between the National Atomic Energy Commission and the Metallurgical Industries Association to act as a link between the Department of Metallurgy and the metallurgical industries. It serves to give the scientists and engineers of the laboratories an opportunity to acquaint themselves with the possibilities and needs of the industry, and to give the latter an opportunity to search for up to date solutions to its technical problems. Author

**N67-14807** Catholic Univ., Santiago (Chile).
**A REVIEW OF THE METALLURGICAL RESEARCH ACTIVITIES IN CHILE [BREVE RESENA DE LA INVESTIGACION METALURGICA EN CHILE]**
David Fuller *In* Arg. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. Metal Working, Vol. I Aug. 1966 3 p In SPANISH; ENGLISH summary (See N67-14801 05-17) CFSTI: HC$7.30/MF$2.00

The metallurgical research in Chile is done exclusively by Universities, specially the University of Concepcion, the Catholic University of Chile and the University of Chile (the last two in Santiago). The areas where most of the research is being done are: molding sands and metal physics, cupola iron casting, structural steel welding, and iron recovery from iron sulfides (an abundant waste product from the copper processing industries). Author

**N67-14810** Cordoba National Univ. (Argentina).
**RATIONALIZED USE OF CONSTRUCTIONAL STEELS [RACIONALIZACION EN EL EMPLEO DE ACEROS DE CONSTRUCCION]**
Dionisio D. Farias *In* Arg. Comision Nacl. de Energia Atomica 1st Latin Am. Conf. on Process Met. and Metal Working, Vol. I Aug. 1966 12 p refs In SPANISH; ENGLISH summary (See N67-14801 05-17) CFSTI: HC$7.30/MF$2.00

The problem of the development of the steel industry in Latin American countries is analyzed. Emphasis is placed in the need to import special steels in the next years and in the necessity of standardizing those which satisfy the requirements of the industries of the country. The economic advantages derived from a correct standardization are pointed out. The role to be played by universities and research institutes in training personnel at all levels is discussed. Author

**N67-14845#** Rice Univ., Houston, Tex.
**RESEARCH AT RICE IN MECHANICAL AND AEROSPACE ENGINEERING AND MATERIALS SCIENCE**
Oct. 1966 20 p refs

Brief summaries are given of research being conducted in areas such as phase shift in ship response, sound dispersion and absorption in ionized gases, continuum theory of porous media, dynamics of heterogeneous fluid mixtures, wave propagation in cylindrical wave guides, optimization theory, flight mechanics, and elasticity and plasticity of shells. An indication of the specific projects being undertaken is shown by a list of publications appended to each summary. A.G.O.

**N67-14921#** Advisory Group for Aerospace Research and Development, Paris (France).
**INFORMATION BULLETIN**
Nov. 1966 45 p refs
(AGARD-66/3) CFSTI: HC $3.00/MF $0.65

The history and position of the National Aerospace Laboratory (NLR) is outlined in the context of research, development, industrial enterprise, and military and civil operations in the aerospace field in the Netherlands. The factors influencing the establishment of the programs are delineated, with overall responsibility for achieving these program goals delegated to three main groups. These include Fluid Dynamics, Structures, and Flight Dynamics and Operations. Summaries of the work accomplished in these main fields of activity are presented. An objective outline of the nature and value of by-products that accrue from space activities is also presented, based on NASA's efforts to disseminate developments resulting from its scientific and technological programs. Aspects covered include science by-products of space research and development; the space program as a stimulus to engineering; the spin-off of hardware objects, and processing and fabrication techniques; and applications of the space program to social needs. M.G.J.

**N67-14995#** RAND Corp., Santa Monica, Calif.
**BIBLIOGRAPHY ON AUTOMATION AND TECHNOLOGICAL CHANGE AND STUDIES OF THE FUTURE**
Annette Harrison Oct. 1966 25 p refs
(P-3365-1; AD-640300) CFSTI: HC $1.00/MF $0.50

The Paper comprises a list of works collected for two ongoing RAND projects: Automation and Technological Change, and a related informal study of future national and international problems. TAB

**N67-15167#** Joint Publications Research Service, Washington, D. C.
**THE PROBLEMS OF COORDINATING SCIENTIFIC RESEARCH**
Ivan Stefanov 16 Dec. 1966 13 p ref Transl. into ENGLISH from Novo Vreme (Sofia), no. 11, Nov. 1966 p 41-48
(JPRS-39155; TT-66-35578) CFSTI: $1.00

The importance of coordinating scientific research due to the advanced specialization of sciences, scientific-research terms, and scientific workers is stressed. The basic tasks of coordination are considered to be: to most expediently combine, coordinate, and delimit the subjects proposed by the various groups, to provide the theoretical and methodological foundation for related subjects, and to concentrate the attention and efforts of the various groups on the most important problems under the given conditions. Difficulties that arise in the practical realization of these complex tasks are analyzed. A.G.O.

**N67-15170#** Joint Publications Research Service, Washington, D. C.
**BRIEF RECAPITULATION OF SOVIET SPACE ACTIVITIES**
V. Parin 30 Nov. 1966 6 p Transl. into ENGLISH from Krasnaya Zvezda (Moscow), 12 Apr. 1966 p 3
(JPRS-38886; TT-66-35310) CFSTI: $1.00

Highlights of the Soviet space program from 1961 to 1966 are reviewed. Emphasis is placed on the effects of these accomplishments on the formation of new sciences, improvement of methods of investigation, and the development of rocket-space engineering. A.G.O.

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